

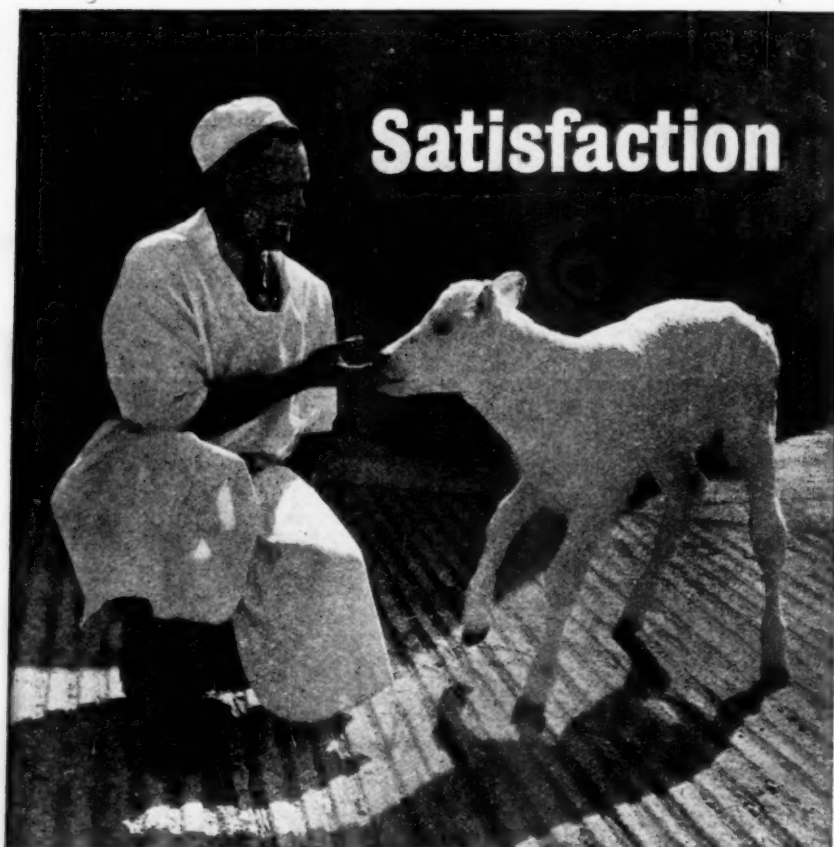
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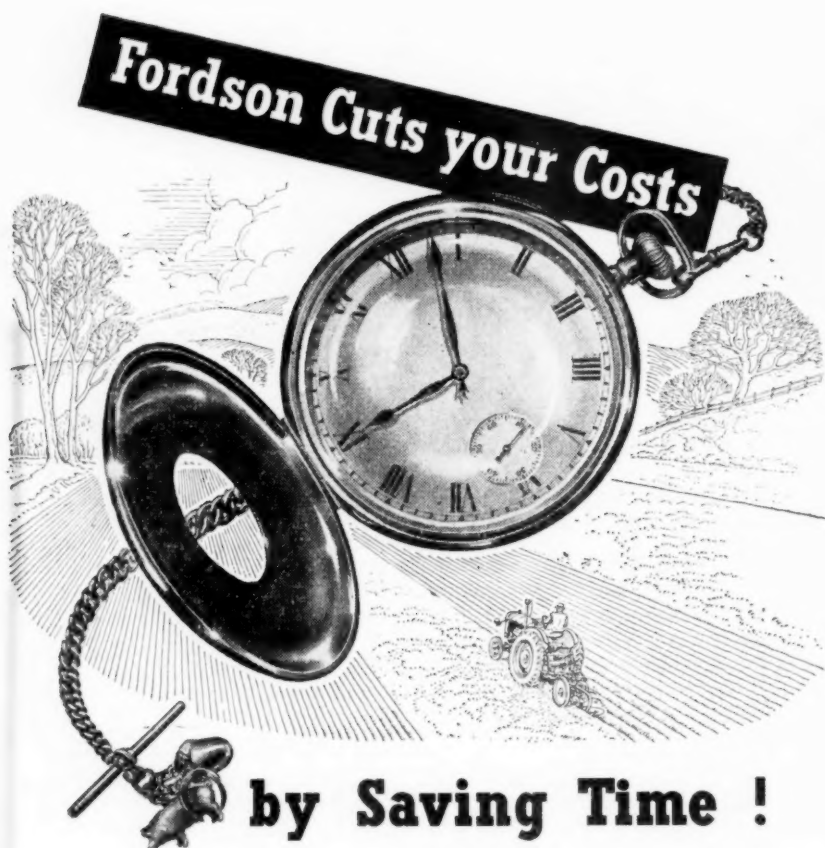
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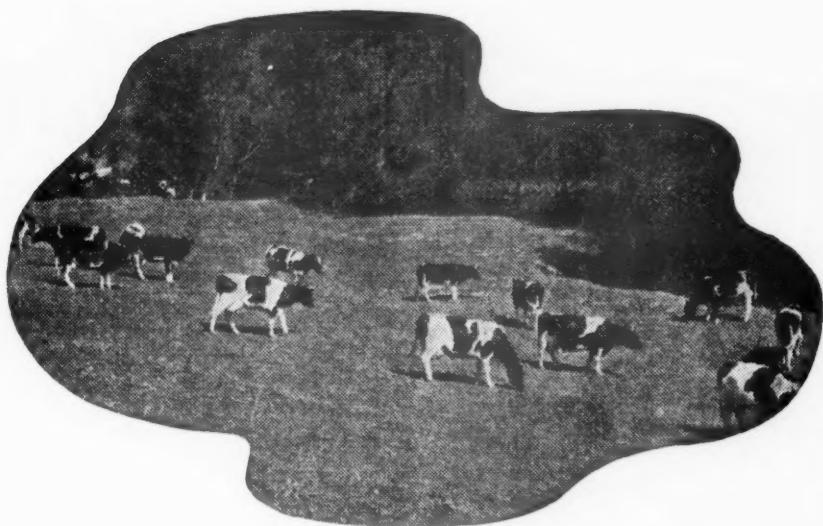
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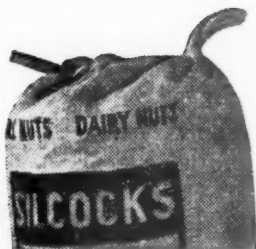
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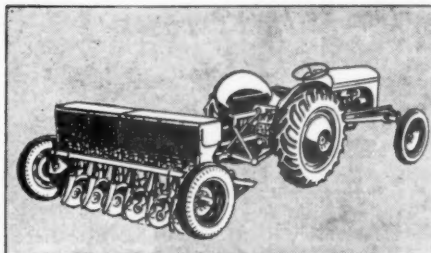
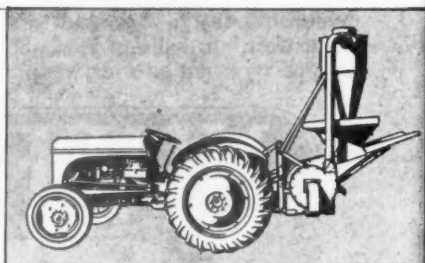
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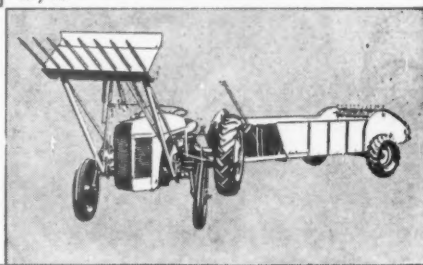
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AGRICULTURE

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MAKING THE MOST OF PHOSPHATE SUPPLIES

T. W. WALKER, B.Sc., PH.D.

National Agricultural Advisory Service, W. Midland Province

In face of the reduced supplies of superphosphate imposed by the present shortage of sulphur, we have to consider the best use that can be made of existing supplies. The writer examines the alternatives, and shows how in many areas, particularly for certain types of farming, compounds, lower-grade basic slag, and rock phosphate can be used profitably.

THE chief types of phosphate fertilizers used in this country are superphosphates (and other water-soluble phosphates such as triple superphosphate and ammonium phosphates), basic slag, and ground mineral phosphate. Much of the phosphate in the National Compound fertilizers is in the form of superphosphate. As most farmers are aware, superphosphate is made by treating mineral phosphate with sulphuric acid, and one of the direct effects of the sulphur shortage is a lowered output of superphosphate. In view of the need to maintain and increase agricultural production, a reduction in the total amount of phosphate used in Great Britain is to be deprecated, and the deficiency in supplies of superphosphate must be made good by the increased use of other types of phosphate. In practice this will largely mean greater dependence on mineral phosphate.

Superphosphate can be used either "straight" or in compound fertilizers; and by selling less "straight" superphosphate, manufacturers might have been able to maintain the level of production of the old compounds without changing the composition. In actual fact the position has been met generally by reducing the amount of superphosphate in the compounds and in some cases by making up the difference with mineral phosphate. For

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MAKING THE MOST OF PHOSPHATE SUPPLIES

example, the old National Compound No. 1 contained 7 per cent N, 7 per cent P_2O_5 (as superphosphate) and $10\frac{1}{2}$ per cent K_2O , while the new National Compound No. 1A contains 8 per cent N, 6 per cent P_2O_5 (as superphosphate) and $10\frac{1}{2}$ per cent K_2O . The old National Compound No. 3—6 per cent N, 12 per cent P_2O_5 (as superphosphate)—has been replaced by No. 3A—6 per cent N, 12 per cent P_2O_5 (9 per cent as superphosphate and 3 per cent as ground mineral phosphate). In the one case the total amount of phosphate has been reduced and in the other, mineral phosphate has been used to replace the reduced amount of superphosphate.

The position facing the farmer then is this: slight changes have been made in the composition of most compounds to which he has been accustomed, smaller amounts of "straight" superphosphate will be available, there will probably be little change in the supply of basic slag, but an increased supply of mineral phosphate. The question to be answered is this: can adjustments of the type and quantities of phosphate used by the farmer be made, so that food production does not suffer? In view of the recent price increases for all fertilizers, this question merits close examination from this aspect alone, and it is difficult to answer without considering the efficient use of fertilizers in general.

Some Results of the 1950 Survey of Fertilizer Practice

Before discussing ways and means of meeting the new situation, it is instructive to examine some results of a Survey of Fertilizer Practice, carried out in 1950 by Advisory Soil Chemists of the N.A.A.S. in conjunction with the Statistical Dept. of Rothamsted Experimental Station. One of the questions the Survey answered was the extent to which compounds were used rather than straight fertilizers, and also in what combinations the nitrogen, phosphate and potash fertilizers were applied. Of the eight districts surveyed, three were mainly arable areas (W. Riding—Vale of York, East Shropshire and East Wiltshire), two were chiefly dairying areas (South-West Cheshire and North Dorset), and others (mainly grassland areas) were represented by Northumberland (between Morpeth and Corbridge), North Buckinghamshire (mainly on the Oxford clay soils) and the whole of Cardiganshire (primarily upland farming). Only the data relating to the use of phosphate with other fertilizers or "straight" is given here.

Percentage of Sampled Fields receiving no Phosphate, Phosphate alone, and Phosphate in combination with other Fertilizers in 1950

DISTRICT	ARABLE			PERMANENT GRASS		
	No Phosphate	Phosphate alone	Phosphate with other fertilizers	No Phosphate	Phosphate alone	Phosphate with other fertilizers
W. Riding	42	8	50	77	12	11
Shropshire	31	4	65	60	2	38
Wilts.	23	5	72	66	5	29
Cheshire	54	10	36	48	13	39
Dorset	37	13	50	80	10	10
Northumberland	45	17	38	70	20	10
Bucks.	55	20	25	85	13	2
Cardigan	49	27	24	94	2	4

MAKING THE MOST OF PHOSPHATE SUPPLIES

In many of the surveyed districts, nearly half the arable fields and three-quarters of the permanent grassland received no fertilizer phosphate at all in 1950. This probably reflects the usual practice of using phosphate on the permanent grass only once every four years or so, and the tendency in the case of arable crops, to apply most of the phosphate to roots and cash crops in the rotation. Particularly in Cardiganshire, however, very little phosphate can be used on the grassland. "Straight" phosphate fertilizers were used to the greatest extent in the poorer grassland districts, and where phosphate was used in the intensive arable and dairying areas, it was mainly in the form of compounds or home-made mixtures. In the case of the compounds, the majority contained nitrogen, phosphate and potash, several supplied nitrogen and phosphate and a smaller number supplied phosphate and potash only.

For fields where phosphate was applied the figures can be further broken down as follows :

**Percentage of Phosphate applied in Various Forms to Tillage,
Leys and Permanent Grassland**

DISTRICT	TILLAGE				LEYS				PERMANENT GRASSLAND			
	Super	Slag	Rock	Com-pds.	Super	Slag	Rock	Com-pds.	Super	Slag	Rock	Com-pds.
W. Riding	20	8	0	72	37	56	0	8	—	—	—	—
Shropshire	9	9	0	82	10	46	1	43	29	20	0	51
Wilts.	7	4	0	89	18	24	0	58	25	29	0	46
Cheshire	17	29	0	54	29	53	0	18	29	34	0	37
Dorset	42	10	0	48	23	25	16	36	20	63	0	17
North'mberl'd	15	38	2	45	4	54	16	26	8	52	35	5
Bucks.	21	43	0	36	—	—	—	—	—	—	—	—
Cardigan	25	63	0	12	2	90	0	8	—	—	—	—

In the mainly arable districts, compounds were the main source of phosphate applied to tillage, with super and slag making a smaller contribution. In the grassland districts, about half the phosphate used on the tillage acreage was superphosphate or slag, and slag was relatively more important in the poorer grassland districts, particularly in Cardiganshire. In all districts the proportion of slag to other kinds of phosphate used on the grassland increased markedly, and compounds were relatively less important as a source of phosphate on grassland. The consumption of rock phosphate was only important on the grassland in Dorset and Northumberland.

As these districts were chosen to represent the major farming types of the country, it is perhaps permissible to draw the following conclusions :

- (a) in the mainly arable areas, compound fertilizers supply most of the phosphate for the tillage crops, but superphosphate and slag supply about half the phosphate used on the temporary and permanent grass.
- (b) in the dairying districts, compounds supply about half the phosphate used on the tillage crops, the rest being supplied as slag or super, which are also the chief sources of phosphate on the grassland.
- (c) in the other, mainly grassland, districts, slag and super are used to a greater extent than compounds even on the tillage crops, and in the one district (Northumberland) for which data are available slag and rock phosphate supply most of the phosphate used on the grassland.

MAKING THE MOST OF PHOSPHATE SUPPLIES

With this broad picture in mind, we can now proceed to examine the question of how best to utilize the available supplies of phosphate. In the case of farmers who buy National Compound fertilizers exclusively, the problem has already been settled by the agreement of manufacturers to reduce either the amount of superphosphate in the compounds or in some cases where this is done, to add mineral phosphate to restore the percentage P_2O_5 to the original level. The farmers who mix their own fertilizers or use "straights" will be faced with taking smaller quantities of superphosphate and leaving it at this, or making up their usual quantities of phosphate with basic slag or mineral phosphate. In the case of basic slag the 1950 Survey showed that it was scarce in most grassland districts. This applied particularly to the high-grade slags, and many farmers had to use lower-grade slags or preferred to do without phosphate at all. It appears likely, therefore, that the farmers accustomed to buying superphosphate may have to take some of their supplies in the form of mineral phosphate, and it is most desirable that the drop in supplies of superphosphate should be met by the increased use of mineral phosphate in those areas and on those crops where it is likely to give as good results as superphosphate.

The results of experiments carried out to compare mineral phosphate with superphosphate and other phosphates are not numerous and certainly not conclusive, but in general it is true to say that on acid soils in the wetter areas ground mineral phosphate can be used profitably on most crops other than potatoes. It is particularly useful on swedes and grassland in such areas. In the drier eastern and south-eastern parts of the country, particularly on calcareous soils, mineral phosphate appears to be of little value for any crop. As it is the wetter areas with predominantly acid soils that are used mainly for grassland enterprises, the simplest solution would be to reduce the superphosphate supplies for Wales, the north-west and south-west of England and some other specified areas, and to use more mineral phosphate there. In this way the least amount of mineral phosphate would be used in the drier, generally less acid and mainly arable areas where mineral phosphate is least valuable, and consumption would rise in those areas where mineral phosphate is likely to be most useful.

Whilst such a solution would be child's play under a dictator, and justifiable in a grave emergency in a democracy, a fairly satisfactory compromise can be reached, especially where it is backed by sound advice from the District Officers of the N.A.A.S., and propaganda by merchants to secure an increase in the use of mineral phosphate *on the right crops in the right areas*. The replacement of superphosphate by mineral phosphate in the wetter areas would liberate more superphosphate for the drier arable areas. Quite apart from the national advantages of such an occurrence, the present market prices are such that it is cheaper to use mineral phosphate where it is effective than it is to use superphosphate.

		Delivered price per ton			Unit price	
		£	s.	d.	s.	d.
Superphosphate (18% P_2O_5)	..	14	13	6	16	4
Basic slag (15% P_2O_5)	..	8	0	0	10	8
Mineral phosphate (29% P_2O_5)	..	12	2	0	8	4

It is worth considering briefly the problems and possible effects of the present supply position in the three main types of farming areas.

MAKING THE MOST OF PHOSPHATE SUPPLIES

Mainly Arable Districts It is the mainly arable areas where compound fertilizers are used most extensively, and of the compounds National No. 1 is the most popular. In future this compound will be known as No. 1A and will contain a little more nitrogen and a little less superphosphate than before. It is most likely that this change, far from being deleterious, will be a step forward to the more efficient use of fertilizers. This statement can be illustrated by the results of recent experiments on potatoes in the W. Midland Province. From twenty experiments on the manuring of potatoes with N.C.F. No. 1 in the absence of dung, carried out over a period of three years, it has been shown that the most profitable dressing of fertilizer was more than 15 cwt. per acre, at the old prices. This quantity of fertilizer supplies in round figures the following equivalents as "straight" fertilizers—5 cwt. sulphate of ammonia, 6 cwt. superphosphate (18 per cent P_2O_5) and 3 cwt. muriate of potash (50 per cent K_2O). Concurrently with these experiments, another series of experiments tested the effects of the separate plant nutrients, and the results showed that on the average, the most profitable dressings were 5 cwt. sulphate of ammonia, 3 cwt. superphosphate and $3\frac{1}{2}$ cwt. muriate of potash per acre. In other words, in order to supply enough nitrogen and potash when using the compound, 3 cwt. per acre superphosphate were being largely wasted. This probably ties up with the history of the old arable land in the mainly arable areas; such fields have generally been well treated with fertilizers, and it is rare to find serious phosphate shortages; in fact in some phosphate-rich soils in the above experiments there was no response to superphosphate at all.

In the case of old permanent grass fields recently pressed into the arable rotation it is quite possible that the amount of phosphate in the old compounds was really necessary, but even in these cases there is little doubt that the new compounds will supply all the phosphate needed by potatoes and beet. Wherever it is the farmer's practice to use N.C.F. No. 1 for cereal crops or grassland, it can also be assumed that the recent change in composition will make little or no difference. Where it has been the practice to use N.C.F. No. 3 for cereals or grassland, the new N.C.F. No. 3A will now have a quarter of its P_2O_5 supplied as mineral phosphate. Whilst this addition of mineral phosphate may be quite valueless in the drier areas, it should be justified in other parts of the country, and on balance was probably the best step to take.

The arable farmer who mixes his own fertilizers will probably not be able to buy all the superphosphate he wants. In the case of roots, cereals and leys he would be ill-advised to make up with mineral phosphate, especially if his soils are adequately limed. If he has recently had his soils analysed, there may be ample scope for saving phosphate on any phosphate-rich soils, by reducing the normal dressings, thus leaving more phosphate for the poorer fields. This point can be illustrated by reference again to recent experiments on the use of fertilizers on short leys for silage, carried out in the W. Midlands in 1950.

As seen from these results, the increase in yield is not of importance generally, except on the deficient soils. Clearly on individual farms there is ample scope for increasing efficiency (and profits) in the use of fertilizers. Where it has been the practice in the drier arable areas to apply "straight" superphosphate to the grassland or cereals, wherever there are still some acid soils it may be possible to get some benefit from mineral phosphate if slag is

MAKING THE MOST OF PHOSPHATE SUPPLIES

unobtainable ; but individual cases are best decided after discussion with the local District Officers in the N.A.A.S. If mineral phosphate has to be used it would generally be best to confine it to the permanent grass, which is the most likely to be short of lime and phosphate, and should give better responses than other crops. Autumn or winter applications will usually be better than late spring dressings.

Experiments on the Use of Fertilizers on Short Leys for Silage

Centre	Increase in yield from 2½ cwt. per acre superphosphate cwt. dry matter per acre	mg. % N/2 acetic acid—soluble P ₂ O ₅ and Classification
1	3.0	3 Very Low
2	2.3	6 Low
3	2.3	12 Satisfactory
4	0.6	13 "
5	0.4	14 "
6	—0.1	10 "
7	—0.5	22 High

No mention has been made of combine-drilling of fertilizers with cereals or placement of fertilizers on potatoes ; wherever possible, of course, such techniques can effect a considerable economy, particularly in the amount of phosphate needed. All too often, however, especially with cereals, the farmer combine-drills a lower rate of compound than if he were broadcasting, thereby reducing the amount of nitrogen applied as well as phosphate and potash. In the interests of general efficiency he should not overlook the necessity of top dressing with extra nitrogen if necessary.

Dairying Districts What has been said about purchased compound fertilizers in the arable areas will apply with equal force in these districts, with the enhanced possibility of getting greater returns from the compounds in which mineral phosphate has been used as a supplement. As evidenced by the Survey of Fertilizer Practice, however, compound fertilizers are used less frequently in these areas and superphosphate and slag are more often applied as "straight" fertilizers. There will normally be more dung available, and wherever dung is applied it will generally be safe to reduce the usual amount of superphosphate applied by 2 cwt. per acre, thereby effecting some economy. Even so, many farmers will find they will be unable to obtain all the superphosphate and slag they would like. Except perhaps for swedes, it would be wise to restrict the use of mineral phosphate to the grassland, and soil analysis will often enable the very best use to be made of it, by selecting those acid, phosphate-deficient grass fields most likely to benefit. In the case of direct reseeding, where it has been the normal practice to use 4 or 5 cwt. superphosphate or equivalent per acre, some of this could be replaced on many soils by mineral phosphate and the amount of superphosphate reduced to 1 or 2 cwt. per acre. The reason for this is that in experimental work, superphosphate has often been observed to give better early establishment and growth than mineral phosphate, but mineral phosphate does eventually in many cases equal the superphosphate, and while the smaller amount of superphosphate will help in the early stages of growth, the mineral phosphate should begin to make its contribution later. In the case of the very low-grade slags which may be available, it is doubtful if they are worth using by farmers, except in the neighbourhood of the sources of production, and mineral phosphate would be preferable on farms for which transport charges on low-grade slags are high.

MAKING THE MOST OF PHOSPHATE SUPPLIES

Other, Mainly Grassland, Areas The chief type of phosphate used in the third major farming type areas according to the Survey is basic slag, even on the arable crops. It will generally be best to utilize any superphosphate and slag obtained on the arable crops. The leys and permanent grass should get the rest of the basic slag obtained, and any deficiency in supplies of superphosphate may be made up with mineral phosphate. It is in those areas of higher rainfall, more acid soils, and more pronounced phosphate deficiency that mineral phosphate can play a most valuable part in meeting the present supply position; and if its use could be extended to much of the untreated grassland, production would undoubtedly be increased, particularly for grazing. A point often met with in advisory work is the use of mineral phosphate for acid grassland which may or may not be limed. If a field is very acid, it is certainly advisable to lime it; it is not normally necessary, however, to lime the soil to neutrality for permanent grass, and under conditions of moderate acidity mineral phosphate may still be expected to give good results. The indirect effect of the phosphate in increasing the clover content of pastures will lead to higher calcium contents in the herbage than can normally be obtained by lime alone, merely because the clover is a plant much richer in lime than the grasses. Three or four cwt. mineral phosphate per acre every two or three years would be a suitable dressing.

Horticultural Crops, Market Gardening, Hops and Fruit Except in the case of fruit grown on acid soils, it is doubtful if mineral phosphate is an adequate substitute for superphosphate or the better basic slags for these crops. For intensive cropping and freedom of rotation these soils are usually adequately limed, and these enterprises are most common in the drier areas. It will often be found, however, that some economy in the use of superphosphate can be made because on many of these farms the soil is already rich in "available" phosphate, owing to heavy applications in the past.

Without resorting to the rationing of superphosphate, the present scheme whereby the superphosphate content in the National Compound fertilizers is either reduced slightly or a small quantity replaced by mineral phosphate, is probably the best compromise. What must be avoided at all costs is a position whereby the better farmer will still get all the superphosphate or basic slag he needs, and the poorer farmer, having no alternative but mineral phosphate, merely shrugging his shoulders and buying no phosphate at all. This would be the worst possible thing that could happen. There are few good farms where some use cannot be made of mineral phosphate or where economies in the use of superphosphate would not be profitable. In the wetter areas of the country the use of mineral phosphate, particularly on the grassland, could be widely and profitably extended, and District Officers should be able to advise individual farmers on the type of phosphate to use, and where to use it to the best advantage. It is perhaps unfortunate that fertilizer prices should have risen at the same time as superphosphate becomes scarce, giving farmers in the areas where fertilizers are least used, a double reason for not using the alternative form of mineral phosphate. It is in these very areas that mineral phosphate will be most valuable, and no opportunity should be lost by all concerned to press the point home.

MULTIPLE REARING OF BEEF CALVES

R. C. COOPER, N.D.A., DIP. AGRIC.

National Agricultural Advisory Service, Holland, Lincolnshire

Store raising on nurse cows has much to commend it as an efficient and economic method of increasing our beef supplies.

MR. HAROLD BOWSER farms 780 acres, plus 200 acres of outmarsh, in two farms at Swineshead and Frampton, South Lincolnshire. He was the prime mover in getting artificial insemination started in the area and lent premises at Frampton to the South Lincolnshire Cattle Breeders' Association. This Association has now been taken over by the Milk Marketing Board, who have moved the bulls to Sutton Bonington, whilst the Boston area is covered by a sub-centre at Donington.

With the bull pens vacated at Frampton, Mr. Bowser started to adapt his premises to a new policy of multiple calf rearing. He covered the bull exercising yards and made in all thirteen boxes, each large enough for a cow and four calves, together with a good-sized covered strawyard fitted with mangers and hay-racks down the centre, so making two separate rectangular yards. All the materials used (except the asbestos sheeting) were second-hand and ranged from old light-railway metals to aircraft landing track. The conversion was done by farm workers, and the whole outlay was within a few shillings of £500.

Each pen, cow and set of calves are numbered, and the cows are let into the boxes twice a day—at 7 a.m. and 3 p.m. for 20-30 minutes only. Provision is made for tying the cows, but once they are used to the calves, tying is unnecessary. The cows go to their own boxes every time.

Ten Calves per Cow Each lot of calves (attested Friesian steers) is being suckled for twelve weeks, and the aim is to rear ten calves per suckling cow—that is, a total of 120-130 reared calves—in the year. This is being done by two batches of four and then, if possible, a two. Some of the cows may, of course, be unable to rear the third batch, but time will tell. On arrival the calves are dehorned and castrated.

The nurse cows are good attested milking stock; breed is not regarded as important so long as the animals are capable of doing their job, i.e., producing 4 gallons of milk per day for the calves. The cows are not served, for it is contended that they will thus milk longer, and whilst feeding the last pair of calves they will be able to increase weight on the feeding quality pastures and then be sold out either fat or in forward condition.

To carry on a system such as this, the whole outfit must be run on efficient lines, just as with a commercial milking herd but without the complication of milking and its attendant long hours, sterilizing utensils, etc.

Feeding is, of necessity, as for high-yielding dairy cows, thus:

7 a.m. 2 lb. dairy nuts, 9 lb. of a mixture of equal parts crushed oats, sugar beet pulp (dry), and grass or lucerne meal.

8 a.m. 7 lb. hay, fed in the racks.

11.30 a.m. 12 lb. silage (cocksfoot-lucerne, 24 per cent protein) per head.

3 p.m. 2 lb. dairy nuts, 9 lb. mixture as at 7 a.m.

3.45 p.m. 7 lb. hay, fed in the racks.

Mangolds are also fed to the cows out on the pasture. The calves are encouraged to eat as early as possible, and by the time they are 12 weeks

MULTIPLE REARING OF BEEF CALVES

old and weaned they are taking 3 lb. of the mixture as above. They also eat what hay they will. Water is available at all times.

Whilst the cows are out to pasture, calves on each side of the racks are allowed out for additional exercise. Thus all the calves have good exercise every day, although they are by no means cramped in the boxes.

At 12 weeks old the calves are taken off the nurse cows and transferred to another set of buildings where there is a large, well-ventilated and well-lit covered yard, and there they are divided into two batches to run on. Feeding starts with 3 lb. concentrates per day, which is gradually increased, plus plenty of good quality hay.

This system started at the beginning of September, 1950, and has fitted in well with the calving of commercial dairy herds, both for the provision of unwanted steer calves and for the freshly calved nurse cows.

At the end of the first year it is hoped to have 50 yearlings, 50 nine months old, up to 25 at six months, and a few stragglers, depending on the milking qualities of the nurse cows. These will all be wintered in the yards and during the following summer grazed on the outmarsh, where an hour in the morning and an hour in the evening will be the total labour charge. Mr. Bowser does not propose to fatten any of these beasts, but a ready market awaits well-reared stock for finishing, either in strawyards or on leys the following summer.

It may be said that here is a system well suited to the arable areas, where beef production has not been profitable. There is no reason why the sequence should not be taken through to its logical conclusion, but in this case, Mr. Bowser prefers to leave that to someone else, and while there are plenty of people keen to produce beef (and muck for the land) by buying in two-year-old cattle and feeding them, he feels that he is justified in letting them do so.

There is another golden side to this business: steer calves are being saved for Britain's larder as prime beef, and there is the attestation bonus per head and the calf rearing subsidy.

This system of store raising appears to be about as foolproof and efficient as any, for one 17-year-old lad looks after the cows and sucklers, whilst in the follow-on yard the weaned calves are tended by an elderly stalwart who has been rearing calves for many years; but as he says, "Never before like this!"

IRRIGATION ON AN EAST SUFFOLK FARM

W. O. and P. O. JOLLY

Kesgrave, nr. Ipswich

Irrigation is not uncommon among market gardeners as a means of increasing productivity, but it has not so far been used on a large scale by farmers for ordinary farm crops. The experience of the writers, farming on light, dry land in East Suffolk, will be of interest to readers farming under similar conditions.

WE are farming two holdings in East Suffolk : one of them, the home farm, known as the Grange, is about three miles north of Ipswich, and with some off-lying fields, comprises some 350 acres of light sandy loam ; the other holding, of 150 acres, lies about four miles away and is on medium heavy land. At the Grange Farm we have a small horticultural unit of about 1 acre of glass devoted entirely to the growing of carnations and tomatoes.

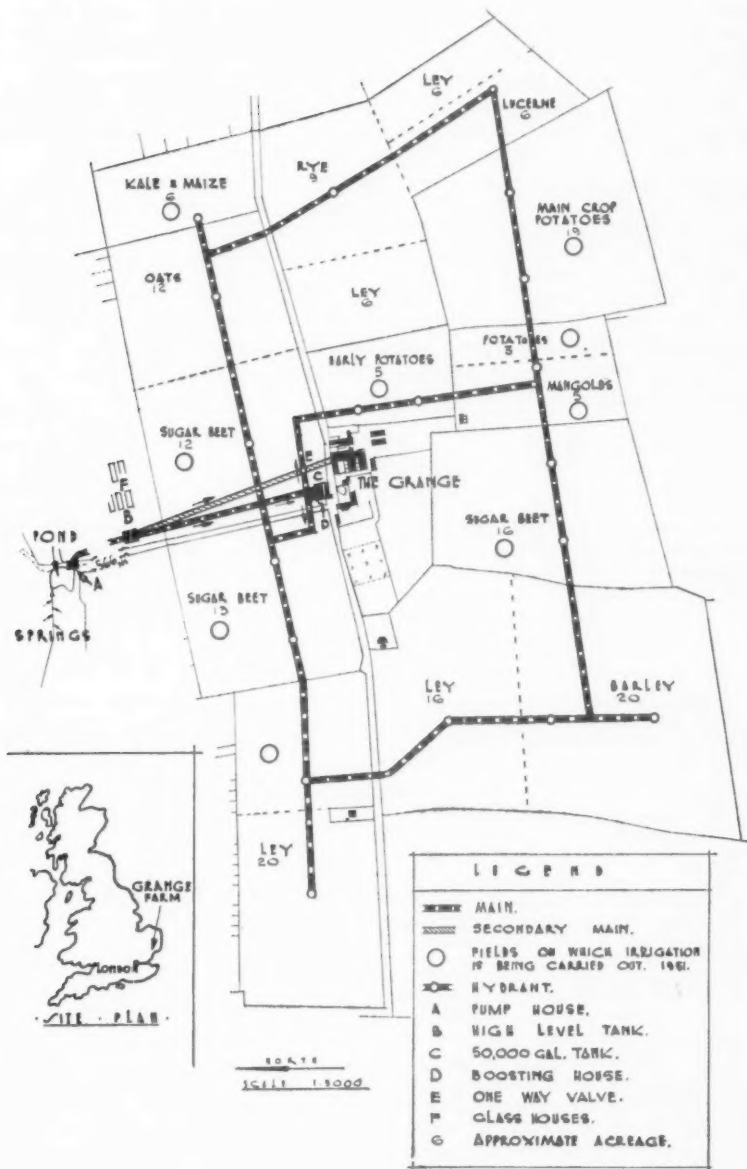
Like most Suffolk farms, ours is mainly arable, although in recent years we have successfully incorporated three- and four-year leys in our rotation. Milk has always been one of our chief products, while sugar beet, potatoes, barley and peas have been the main cash crops. Oats and other fodder crops have been grown for stock feeding.

Not all our farm readily lends itself to irrigation, and our irrigating activities have been confined to about 170 acres on the Grange Farm. Here the very light sandy loam, on a sand or gravel subsoil is often acid and generally lacking in humus. The average annual rainfall for the district is very low—21 inches, and in some years only 18 inches has been recorded ; moreover, a high proportion of this rain falls during the winter and is of little use for plant growth. The position is further aggravated by the fact that there appears to be a high rate of evaporation. Before adopting a policy of irrigation on the farm, we had gained a considerable amount of information and experience with horticultural crops, and being well satisfied with the results we tried a number of experiments to ascertain whether irrigation would help in general farming, first conducting trials in a small way on crops such as sugar beet which would readily respond to this treatment.

Plan and Practice In 1947 we decided to develop our present system which is shown diagrammatically in the plan on p. 315. A study of this plan will help to show how irrigation fits into our general farming practice, both in regard to the lay-out of the system and to the crops grown.

Fortunately crag springs afford a good continuous supply of clean water. (Crag is a local term for geological formation of sand in which a high proportion of calcareous shell is present.) This water is pumped half a mile from the pump-house marked A either into a high level tank marked B, which supplies the glasshouses and farm buildings, or into a ground level reinforced concrete tank marked C. From there a booster pump passes the water under pressure into a 4 inch underground main. Both of these pumps are operated electrically. At each point on the main marked with a circle a hydrant can be fitted, the water then flowing through a 3 inch over-ground movable main to the place where it is required.

IRRIGATION ON AN EAST SUFFOLK FARM



The Irrigation System at Grange Farm, Kesgrave, nr. Ipswich.

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We have tried various methods of putting on the water, but we much prefer the oscillating spray-lines, except perhaps when grass or tall crops such as maize are irrigated; then a rotary gun is satisfactory. With our output of 5,000 gallons per hour we can irrigate about one acre of land at a time, and in just over nine hours can apply the equivalent of 2 inches of rain.

For the crops we irrigate, such as sugar beet, early and main potatoes, brassica, leys, lucerne, kale, and maize, we find that a 2 inch application has so far given the best results.

Apart from the employment of a brick-layer and electrician and an A.E.C. excavator, the installation of the plant was undertaken entirely by our own labour. Some idea of the value of our irrigating system will be obtained from the following costs and results. Our costings, both overhead and running expenses have been scrutinized by the Farm Economics Branch of the School of Agriculture, Cambridge. At the same time due allowance has been made for every known factor, including interest of capital and depreciation, the one exception being our own supervision.

The year 1950 was by our standards a wet year, consequently only 61 acres were irrigated and the cost was as follows:

	£	s.	d.
Overhead charge per acre	5	0	3
Irrigation charge for one 2 inch application	1	4	3
Total cost per acre	6	4	6

As overheads (interest, depreciation, etc.,) are the largest factor, it will be seen clearly that if the acreage had been doubled then the cost would have been:

	£	s.	d.
Overhead charge per acre	2	10	0
Irrigation charge for one 2 inch application	1	4	3
Total cost per acre	3	14	3

As to results, field trials have been undertaken in conjunction with the Sugar Beet Research and Education Committee and members of the staff of Rothamsted Experimental Station, and in 1950, irrigating gave an increase of 3 tons per acre of washed beet.

	£	s.	d.
3 extra tons sugar beet at £5 16s. per ton	17	8	0
Deduct the cost of irrigating per acre	6	4	6
Extra cash return per acre	11	3	6

Moreover, the weight of the tops was increased by a half ton per acre. In really dry years the advantages of irrigation have been much more pronounced.

Subsidiary Advantages Our irrigation system is so arranged that other advantages accrue, the chief of these being that cattle drinking troughs can be supplied in any field from the underground main. This is made possible by connecting the pipe-line running from the high level tank marked B on the plan to the farm buildings at the point marked E to the underground main with a one-way valve. Thus when irrigation is not actually in progress the meadow tanks are fed by gravity. Also, since a good supply of clean water is available, we are able to utilize our leys or lucerne on any field for stock grazing. We use a considerable quantity of straw for compost making, the process being much simplified as watering presents no difficulties and the most desirable sites can be chosen

IRRIGATION ON AN EAST SUFFOLK FARM

for the heaps. Undoubtedly there are additional uses for which a system such as ours could be utilized, although we have not yet explored them—for example, the washing of vegetables for marketing.

The pros and cons of irrigation may, as experienced by us, be summarized as follows :

PROS.

1. Increased yields, especially in dry seasons.
2. General inducement to a higher state of cultivation and fertility, having removed to a great extent the fear of drought.
3. Ability to produce crops for sale, e.g., brassicas, and green food for milking cows during dry weather.
4. Catch cropping is more certain.
5. Adaptability of system to other uses.
6. Last, but not least, psychological effect, as measured by the farmer's temper.

CONS.

1. Heavy initial outlay.
2. Often additional work during normally busy times, involving long hours and weekend work.
3. Additional supervision and attention of a key man.

On balance we consider that the advantages outweigh the objections and that irrigation for ordinary farm crops, especially in light land areas of the country where there is a low annual rainfall, is worthy of serious consideration.

SACKED COMBINED BARLEY LEFT IN THE OPEN

T. D. DEWES

National Agricultural Advisory Service, Buckinghamshire

The writer's account of an experiment in Buckinghamshire last autumn shows that bagged barley left in the open for a short period after combining, is likely to suffer little harm if the sacks are carefully turned, but exposure for any long period will inevitably cause deterioration of the grain.

DURING the past few years many farmers have advocated leaving sacked combined grain in the field immediately after harvesting. The contention has been that not only was no harm done to the grain, but there was an appreciable reduction in moisture content. To obtain some conclusive data, an experiment with barley was designed for the 1950 harvest, in collaboration with the Department of Scientific and Industrial Research.

SACKED COMBINED BARLEY LEFT IN THE OPEN

A wire netting cage 18 feet square and 6 feet high was placed on ground near the Buckinghamshire A.E.C. office at Stoke Mandeville. This piece of land was sown to barley, and a stubble left to simulate field conditions. A combined thermo-hydrograph recorded continuously on a chart the atmospheric temperature and relative humidity. Rainfall figures were obtained from a nearby meteorological station and are shown in Fig. 1 together with the average weekly relative humidity. Samples were taken from the sacks by a special spear which extracted 1 oz. of grain with small disturbance. The Department of Scientific and Industrial Research agreed to make the determination of moisture content by the oven method, the samples being posted to them in air-tight bottles.

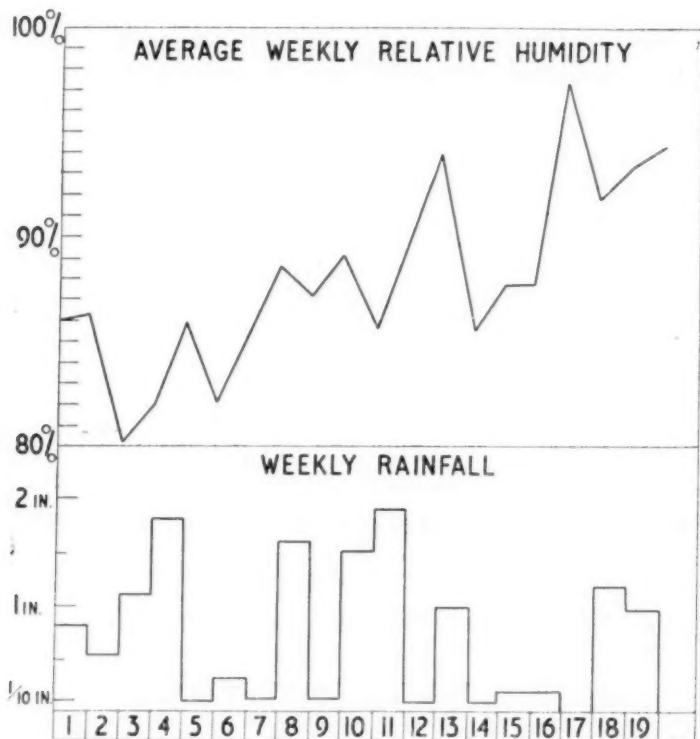


Fig. 1.

The experiment was conducted from September 4, 1950, until January 15, 1951, and was divided into two sections, referred to here as "A" and "B".

"A" Six 1-cwt. sacks of barley straight from the combine.

"B" Six 7-lb. sacks of barley from the same source as "A".

Samples for moisture determination were taken once a week from "A", and the sacks from "B" weighed and variations recorded.

SACKED COMBINED BARLEY LEFT IN THE OPEN

Section "A" The sacks were turned every other day, except when the top was saturated with rain. Turning was then left until the top had dried out—sometimes as long as three or four days, the mouth of the sacks always taking longer than any other part to dry out. The sacks were also marked "East" and "West", in order to make certain that they were only turned over and not placed in a new position relative to the prevailing wind. Care was taken, too, to see that the sacks were not put down with the wet end on the ground, since it has previously been found that this led to quick sprouting. Two samples were taken at various places from each sack and the recorded moisture content was tested and recorded.

It was noticed that from November 25 onwards sprout growth developed rapidly to a depth of about $1\frac{1}{2}$ inches all round the sack, except at the mouth; the greater thickness of the sacking at this point may have deterred it.

Moulds were apparent on odd grains during the fourth week of the experiment, but they did not develop throughout until after the last week in December. On close examination of samples taken on January 8, *Alternaria* was present throughout, both inside and outside the seed coat; also several other genera of fungi and of bacteria were fairly generally present on the outside of the grains. This distribution of fungi is quite normal, but the amounts of each present were too great for storage without treatment.

Germination tests were also carried out from the same sample and gave very variable results, ranging between 8 and 89 per cent. It would appear that all the grains were on the border line between germinating and remaining inert.

Section "B" Two sacks were placed on the ground and given the same turning treatment as the sacks in "A". Two sacks were placed standing on flat bricks and never turned. Two sacks were placed on a wooden box 6 inches clear of the ground and were protected by a roof, though rain could beat in on all sides; these were not turned.

It is interesting to note that sprouting took place during the period November 6-25 in the sacks outside without protection. This spread rapidly until all the grain was spoiled. Increases in weight varied between 1 lb. 12 oz. and 2 lb. 1 oz. The two sacks that were protected and standing clear of the ground had a weight increase of 4 oz. and 6 oz., the grain showing no signs of sprouting until the first week in January—due, no doubt, to the free circulation of air all round the sacks.

It will be seen from Fig. 2 (p. 320) that the amount of moisture in the grain used in the experiment was roughly in equilibrium with the atmospheric humidity throughout the period. The moisture content remained approximately constant, apart from the effect of rainfall over the first two weeks. It then rose steadily to over 22 per cent. Periods of heavy, prolonged rain resulted in corresponding increases in moisture content, showing mainly in samples taken from the mouth of the sacks.

Deterioration in quality was first noticed during the fourth week, when moulds appeared on odd grains under the mouth of the sack. There was presumably similar slight deterioration near the bottom. The final result of long exposure was poor germination and a very serious attack by fungi.

SACKED COMBINED BARLEY LEFT IN THE OPEN

AVERAGE WEEKLY MOISTURE CONTENTS

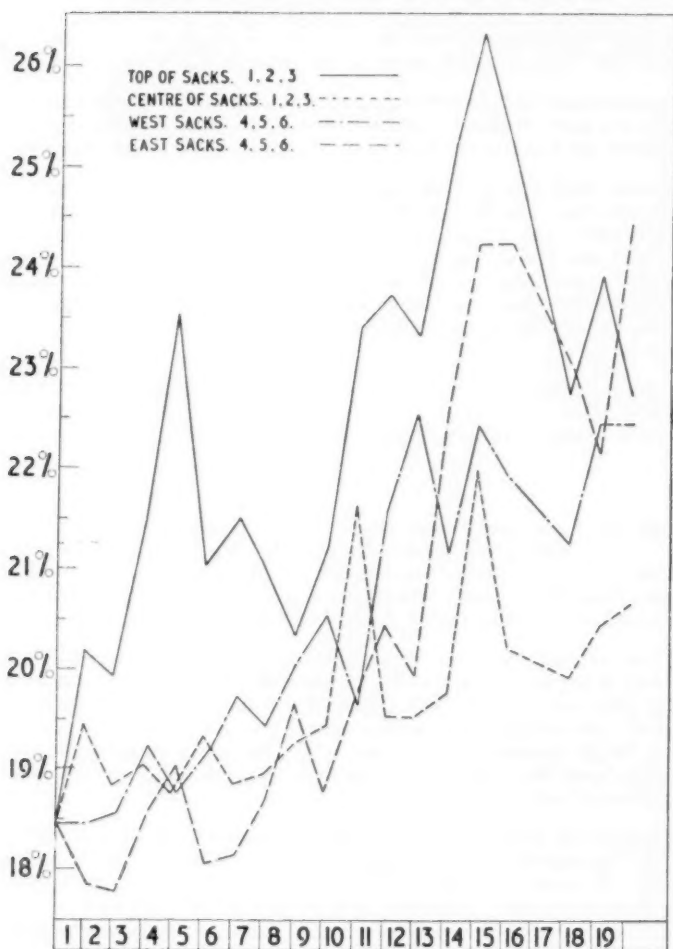


Fig. 2.

SACKED COMBINED BARLEY LEFT IN THE OPEN

The Lesson from the Experiment The chief purpose of this experiment was to investigate the condition of the grain after prolonged exposure. From the practical aspect, interest centres on the question of leaving the grain in the open for only short periods immediately after combining. The results from this part of the experiment show that barley comes to little harm if left in the open in sacks for a short period, provided careful attention is paid to turning ; but long exposure is likely to result in a deterioration in quality.

During good August weather the average relative humidity of the atmosphere is low enough to result in some drying of grain which is harvested in damp condition and left in the open. Later, in the autumn, the normal relative humidity of the atmosphere is not low enough to provide a certain means of reducing the moisture content of grain to a safe storage figure. The average weekly relative humidity at the start of the experiment was just over 80 per cent. This tended to rise to over 90 per cent at the end of the period.

Greenstuff occurring in relatively dry grain is dried by transfer of moisture from it to the grain ; this results in its easier removal in a dressing machine. The transference is usually effected in a few days, and is perhaps the most important advantage to be gained by leaving grain in the open after combining. Damp grain or grain containing a considerable amount of greenstuff is less liable to suffer damage from heating if left in the open in bags for a few days after combining than if stored in a heap, either loose or in sacks without adequate ventilation.

SMALL-SCALE TABLE POULTRY PRODUCTION

A paper read at the National Agricultural Advisory Service Conference, Northampton, July 25, 1951, by **R. B. SHAW**, Head of Department of Poultry Husbandry, University of Nottingham, School of Agriculture, Sutton Bonington.

PROVIDED the finished article can be sold profitably, it is usually sound business to make the utmost use of existing plant ; and in the case of a poultry farm this can be extended to include the greatest possible use of breeding stock. My remarks are addressed to those who wish to add chicken production to their other activities but have little or no knowledge of this section of the industry. It is assumed that in the main the equipment is already on the farm and is available for this purpose from May to December each year.

On some farms there may be equipment which lends itself admirably to the raising of table chickens ; in other cases the position may be less satisfactory, but generally what is satisfactory for use in the normal rearing season will be reasonably satisfactory at other times.

On several large and successful table poultry plants operating in England before the war the policy was to start and finish the chickens indoors, and during the intermediate period of approximately 6 to 8 weeks the birds were

SMALL-SCALE TABLE POULTRY PRODUCTION

in folds or in small flocks on range or semi-range. This method was also found to be the best in experiments conducted at Wye College in 1935-37, but there the indoor birds were confined to cages.

At Sutton Bonington, where we have produced table poultry on a limited scale each year since 1924, we have had great success with rearing entirely out of doors (killing birds direct from the run) and also by intensive rearing. Surplus cockerels are transferred from range to an intensive house at the age of 8 to 10 weeks. The disadvantages of outdoor rearing are :

1. Over a period of years the heavy manuring of the land may be detrimental to the well-being of the future layers and breeders : in other words, table chickens may be allowed to use land which should be reserved for the rearing of the farm's replacement stock.
2. The units are more scattered, thus involving more labour.
3. There are management difficulties during severe weather which may result in the production of inferior birds.

When chickens were reared intensively for the first eight weeks and then transferred to arks in the winter months, some groups received a check from which they never entirely recovered. There is always the risk, particularly under certain weather conditions, of trouble from coccidiosis when chickens are moved outside.

Our intensive method is to start the chicks in a battery brooder (situated in the brooder house), about 80 to 100 to each tier, depending on hatching results. After one week half the chicks are moved into another tier, thus doubling the space allowed. When 10 to 14 days old they are transferred to a table-type brooder with a hover at one end, thus enabling the chickens to get away from the heat at will. This piece of equipment is not essential in summer but it is helpful in winter. When three weeks old they are transferred to a compartment in the brooder house, where they are floor-brooded for a further two or three weeks. They remain in the brooder house compartment until 10 weeks old, and then moved to another building where the compartments are larger. Killing takes place at the age of 16 to 18 weeks, the cockerels being the first to go.

All the heating is by electricity, which, of course, incurs the risk of current failures ; a failure of several hours' duration does not necessarily cause deaths, but it can have a detrimental effect on the chickens, in that at a later stage they may fail to fatten. We have this year been forced to install a generator. This has been in action a number of times and has eliminated anxiety and extra labour in both the incubator and brooder houses.

The size of the brooder house compartments is 90 sq. feet (7 feet 6 inches \times 12 feet) and the follow-on house 98 sq. feet (11 feet 6 inches \times 8 feet 6 inches). On the basis of 40 birds, the allowance in the brooder house is 2.26 sq. feet per bird. Thirty-five birds in the follow-on house would have 2.8 sq. feet per bird. We put the maximum at 40 for a compartment of this size (2.4 sq. feet per bird).

Management Of the more important points in management, the first is that one must start off with strong and healthy chicks. Such birds will respond to good management and good feeding and they can be reared with little or no loss and fattened successfully. It is true that strong chicks will withstand some mismanagement, but there is almost always some mortality and a less satisfactory carcass in the end. Inferior chicks will be

SMALL-SCALE TABLE POULTRY PRODUCTION

unprofitable because they will not respond sufficiently to good treatment, and are likely to succumb to coccidiosis more readily than the stronger birds. If you want your chickens to thrive give them sufficient space and look to the ventilation of the houses.

Whichever method of rearing is adopted, coccidiosis is the great enemy. Outside the daily movement of the folds will give a measure of control ; indoors the regular removal of litter can be exercised. An important factor is that the attendant should be keenly observant, so that he can act immediately the chickens show the very first symptoms of the disease. Needless harm and loss is caused when the attendant just " doesn't notice " or delays doing something about it. The skilled poultryman can often tell quickly when coccidiosis is causing trouble, but the only *certain* information comes from a veterinary laboratory. Once it is known that coccidiosis is present, very effective remedies in the form of certain sulpha drugs such as sulphamezathine are available. But I am firmly of the opinion that the standard of management has a great influence on the extent to which coccidiosis and other troubles manifest themselves.

Some amusement was caused at the Midland College in the late 1930s by the provision of old slippers and shoes of various sizes into which the attendants had to change on entering the intensive houses. The idea was to reduce the possibility of introducing coccidiosis infection into the rearing houses. This routine had to be abandoned during the war because the supply of second-hand footwear became exhausted. It may have been coincidence (I take a lot of convincing over matters of this kind) but we had much less trouble with coccidiosis while this regulation was in operation, and we had a rather severe outbreak soon after the slippers were withdrawn. Similarly we never had any blackhead in turkeys while these precautions were taken.

Feather picking and cannibalism have been a prominent source of worry and loss on many intensive plants. We have had little experience of this at the School of Agriculture, but I should be inclined to associate vice of this kind with one or more faults in management such as overcrowding, unsuitable atmosphere in the building, wrong method of feeding, and unsuitable diet. Other factors are idleness and possibly the condition of the birds' blood, but these are related to the points just mentioned.

It is advisable to have dry food before the birds all the time but never have a dry water vessel.

In case there be any misunderstanding let me say that there should be one age of chicken only in any one house or compartment.

The usual attention should be given to hygiene. The litter should be replaced as required ; and this may be a matter of every few days or the deep litter method tried out. Some effort should be made to simplify litter removal so that it is taken out of the building and into a manure-shed as quickly and easily as possible. At Sutton Bonington we now have a narrow trolley which was specially made for the passage in the follow-on house and of a capacity to take all the litter from one compartment. This trolley runs down a ramp at the end of the building, and a few yards further on is the manure-shed. Stirring the litter daily may be found worth while. To minimize the wetting of the litter it is wise to have the water vessel in the corridor and placed so that the birds can drink readily. This arrangement also reduces labour. Failing this, the water supply should be arranged to ensure the minimum damping of the litter. Wet litter is an abomination.

SMALL-SCALE TABLE POULTRY PRODUCTION

Adequate and non-spill mash hoppers are most desirable, but they are not easy to find. Equipment should not occupy floor space. Slats or perches could be provided in one part of the compartment, but we ourselves have never installed them.

Feeding : Chicks A really good mash for the early stages does give chicks a good start to their short lives. During the past ten years we have had to do without this and without that, yet the chicks have responded valiantly. The chicks have dry mash in front of them all the time and we have found it a good thing to give them a feed of grain late in the day.

It has been our habit to supply artificial lighting in the evening, October to March, until the chickens are 8 to 10 weeks old, but as we have not done this experimentally we cannot say that it is absolutely essential to maximum results. We have a strong feeling that it does help the young chicks along—say up to six weeks of age, particularly when the ingredients of the mash are not of high quality.

You may wish to purchase made-up mash or pellets, but if you prefer to make up your own and can purchase individual foods here is a formula which has given excellent results. It has had to be varied to conform to the conditions of the food market, but in the main it has been largely as follows :

						DAY-OLD TO 4 WEEKS
						lb.
Fine millers' offals	}	Mix together	..	..	32	½ pint
Cod liver oil (high-grade)						
Fishmeal						
Limestone flour	}	Mix together	..	..	8	
Dried milk or whey						
Ext. dried yeast						
Grass meal	..	..	..	..	..	6
Maize meal	..	..	..	..	..	21
Ground oats	..	..	..	..	..	14
Barley meal	..	..	..	..	..	12
						100

This mash (dry) is in front of the chicks all the time.

Growers When foods like dried skim milk or whey or dried yeast were scarce, or expensive, we have had to reduce or omit such ingredients after 4 weeks. A mash which is about half way between the starter and the growers' mash is given. We have twice experimented with protein levels at the 8 to 16 weeks stage and have found over the two years that it is not economical to continue using the starter mash throughout. In fact we have had equivalent results in carcass size and quality when the protein level has been still further reduced, i.e., using a lower protein ration than we have done in the past.

During the 8 to 16 weeks period good and correctly balanced food will exert a favourable influence on rate of development and quality of carcass, and if one wishes to turn out birds of the highest quality the better the quality of the food the easier the task. Nevertheless I pay full tribute to the adaptability of the chickens' digestive system. When I think of the quality of the rations fed before the war and what I have been forced to give the

SMALL-SCALE TABLE POULTRY PRODUCTION

birds for considerable periods during the past ten years I marvel at the results. The finished article may not have been of super quality but to me it seemed remarkably good when the standard of feeding was considered. But good results cannot be obtained on mediocre rations unless you are dealing with robust chickens that have a good start. I would say, "Let us not be too fussy about the quality of rations for table poultry". Here is a ration that gave surprisingly good results but of course one should strive to give something better.

							lb.
Fine millers' offals	..	..	..	..	..	..	38
Cod liver oil (high-grade)	..	..	..	..	..	..	$\frac{1}{2}$ pint
Fishmeal	..	..	..	..	..	..	8
Limestone flour	..	..	..	..	..	..	2
Barley meal	..	..	..	..	..	..	22
Maize meal	..	..	..	..	..	..	16
Grass meal	..	..	..	..	..	..	14
							<hr/> 100

I am not advocating the use of this ration, but I mention it as an illustration of the kind of feeding we were driven to as recently as 1948. It is certainly a bulky ration and far from what is scientifically correct. The finished article was not of first-class quality but very reasonable in the circumstances.

The following ration was used last winter, and the birds caught my eye on more than one occasion when they were on the shaping shelf. They were the best birds we had turned out for some time.

							lb.
Fine millers' offals	..	..	..	..	..	..	26
Cod liver oil (high-grade)	..	..	..	..	..	..	$\frac{1}{2}$ pint
Fishmeal	..	..	..	..	..	..	5
Limestone flour	..	..	..	..	..	..	2
Grass meal	..	..	..	..	..	..	5
Ground oats	..	..	..	..	..	..	28
Barley meal	..	..	..	..	..	..	28
Maize meal	..	..	..	..	..	..	6
							<hr/> 100

In the intensive houses before the war we fed dry mash only, but in 1940 the quality of the foods deteriorated so much that we were forced to introduce two wet mash foods per day in addition, and this routine has continued to the present day. This involves additional labour.

Quality and Size of Chickens Required This leads me to refer to the requirements of the customer and in the first place I refer to the housewife. Producers who have supplied direct to the consumer for many years should know something about the consumers' likes and dislikes. We at the School of Agriculture belong to these producers and, judging by the enthusiasm with which customers praise our birds, it is obvious that we supply what the housewife wants. She does not make it necessary for us to produce chickens which would fetch "Surrey" prices on the London market but rather birds that before the war would fetch 1d. or 2d. per lb. below the lowest Surrey price. Sometimes the customer did get higher quality birds because frequently some of our birds did make the lower Surrey price at Smithfield. But taking the year through, many

SMALL-SCALE TABLE POULTRY PRODUCTION

of the birds would be of the quality I first mentioned. The weight of bird favoured by our private customers is about $3\frac{1}{2}$ lb. (live).

The London salesmen are exacting in their requirements (if one is to get the best prices) and often in the past it has been the most profitable market to cater for, but from what I have already said it can be seen that throughout the country there are customers who would gladly purchase birds of the quality I have described. There is, I feel, a very limited market for the highest quality birds.

This should mean then that the task facing the novice or comparative novice to table poultry production is not quite so formidable as is sometimes thought. It will naturally depend on how the producer intends to market his birds. If it is to be a retail trade, and there are points against this, the production of the birds is less difficult but if it is intended to sell boxes of graded birds to a wholesaler or retailer then the task is considerably increased.

Production and Purchase of Day-old Chicks

Some people may wish to buy day-old cockerels. If so, they should endeavour to find a breeder whose breeding stock is not too far removed from table type in conformation. Also you want birds capable of quick growth. I am assuming, however, that I am expected to help those who wish to breed at home and that in most cases Rhode Island Red and Light Sussex are the available breeds. To make the best of breeds which have been bred over a period of years for egg production, it is necessary to select the most suitable birds. These are the medium to large birds with long and flat backs, good depth, and long straight breast bones. Consistent with good egg production, try and retain those qualities in your stock. The Rhode Island Red is not really a table breed, but if the narrow-backed and very deep-breasted birds are avoided the others will provide very useful material for crossing with Light Sussex. Incidentally the incidence of twisted breast bones and breast blisters would be reduced.

If you have White Wyandottes on the farm then you have excellent material for crossing with Light Sussex. The great reduction in the number of White Wyandottes in this country has been a serious loss to the table poultry industry. To cater for the *petit poussin* or small chicken trade, you would probably be satisfied with the mating of White Leghorn male to Light Sussex females.

If you wish to further improve the quality of your table poultry you would require to purchase an Indian or Jubilee Game male and cross with a few specially selected Light hens and then use the first-cross males (Game \times Light Sussex) with Light Sussex. It is important to obtain the utility type of Game, otherwise you will probably have most disappointing results with fertility. Faverolles males would also improve table quality. New Hampshire Reds have the reputation of possessing the factors for broad breasts and quick growth of feathers and body, and may therefore prove a useful adjunct to British table poultry production. A fast rate of body development is an important economic factor. The crossing of two varieties of Sussex, such as Brown or Red Sussex with Light Sussex, has been favoured by some.

A worthwhile contribution to the production of well-shaped table chickens is to make a first selection of future stock males when they are about sixteen weeks of age. Birds with or nearest to the desired conformation and weight

SMALL-SCALE TABLE POULTRY PRODUCTION

at this age are more likely to produce progeny of similar quality and weight at the same age.

To start a programme of hatching out table chicks from May to December or January means continuing to use the same hens which have produced the pure-bred stock and mating them to males of another breed, e.g., Rhode Island Red males to Light Sussex hens and Light Sussex males to Rhode Island Red hens. Pure Light Sussex can be hatched for table production, but crosses are generally favoured as giving better fertility, greater vigour and possibly quicker growth.

If then or later insufficient eggs of the required quality are forthcoming, it will be necessary to mate some of the yearling hens. This will certainly be necessary later in the summer when production wanes. Another factor which is liable to reduce output of day-old chicks is a reduced rate of fertility during the summer from flock matings in field houses. This can be a serious factor economically, as excessive wastage of eggs may occur.

In the past it has been said that June and July are bad months for chick rearing but that has certainly not been our experience, although one is liable to meet some coccidiosis. The finest table birds produced by us over a period of years were hatched May to August and sent to London, September to December.

A period of great difficulty regarding supplies of sufficient suitable eggs will almost certainly be encountered in September and October. Nearly all the old birds will have gone into a moult and there may not be enough eggs of the required size coming from the pullets. It will be gathered from this how necessary it is to have a good batch of December or January hatched pullets. A marked reduction in size and quality of chicks can often be observed when a switch-over to pullet breeding takes place.

Chickens hatched in November, December and January, and sold during March and April, usually secure the highest price of the year.

It is necessary to run a reserve of male birds as there can be considerable wastage, especially where flock matings are operating; also it is not conducive to the best results to have the same males mated over a prolonged period.

Economic requirements of the present day are the maximum output per man and quick growth of chickens. In the latter connection we may receive substantial help from the use of antibiotics, which are now in process of trial both in America and this country.

During the past three years we have at Sutton Bonington done some work in the use of stilboestrol (15 mg. pellets), but while this has brought about a very noticeable improvement in appearance it has not increased the weight of the carcass. It follows, therefore, that unless one is to receive an enhanced price for the treated birds it is hardly an economical proposition. When killing chickens at 16 weeks of age it was found that equal results were obtained when the implanting of pellets was done at anything from 8 to 11 weeks of age. By far the most interesting and spectacular results were obtained last year with the caponizing of old ($1\frac{1}{2}$ to 3 years) males, Rhode Island Red, Light Sussex and Brown Leghorns. They were transformed from lean, tough-looking birds into carcasses resembling good quality old hens. Our buyer readily gives 9d. per lb. live weight more for them than for untreated birds. The period required to obtain this effect varies with individual birds from 5 to 10 weeks. It also has a favourable effect on their weights.

THE NINTH WORLD'S POULTRY CONGRESS

R. COLES, B.A., PH.D., M.SC.(AGRIC.), M.SC.(ECON.)

Ministry of Agriculture and Fisheries

Sixty-two countries were represented at this Congress held in Paris on August 2-9, where, as the Ministry's Chief Poultry Officer, Dr. Coles, shows in the following article, the subject of nutrition by far attracted the greatest attention. (The previous World Poultry Congress was held in Copenhagen in 1948.)

INTERNATIONAL conferences are apt to provoke both exasperation and amusement; exasperation when language limitations prevent one from clearly questioning a speaker from overseas—amusement when some unfortunate person makes a gaffe in a tongue foreign to him. Such an instance arose when an interpreter spoke of *Wetnesday* for Wednesday at a time when, suitably enough, the heavens were doing their best to drown the Paris Poultry Congress. Then there are the disappointments—for example, when a paper with an impressive title turns out to be a trifling account of facts already well known. In this respect the Ninth Poultry Congress followed the pattern of previous World Congresses in having not a few poor and insignificant contributions, but, also, to even things up, several first-rate papers delivered by internationally famous people.

The papers read at the Congress were rarely concerned with original work. In some instances they were historical accounts of developments in the country of the speaker—new marketing schemes, new breeding policies, and, on this occasion, all too often accounts of the progress of disease. Other papers were omnibus accounts of recent scientific research work carried out by the authors or suggestions for future research work indicated by recent investigations. In such instances, great interest centred round the discussion which followed the presentation of the paper.

It was of some value to scrutinize the titles of the 138 papers presented, and from this examination to form a fair idea of world trends in the poultry industry. Further confirmation of these could be drawn from the attendance when certain papers or groups of papers were read at the five series of sessions, dealing with Breeding, Nutrition, Disease, Economics and Organization. It was clear that the greatest attention was focused on nutrition, with disease control and the marketing section of the economics session vying for second place. It was apparent from the questions put to the speakers (and the questioners included many professional poultry keepers as well as scientists) that some anxiety prompted the widespread interest in these sections; an anxiety having its roots in rising costs and the increasing threat of disease—in particular, Fowl Pest. The Congress members were keen to discuss any suggestions for reducing rising food bills, the toll from disease and costs incurred by poor marketing.

Nutrition In the field of Nutrition most interest centred round the papers on the Animal Protein Factor and the value of antibiotics. Here the majority of papers were presented by speakers from Great Britain and the U.S.A. During the last two years the A.P.F. complex of factors, assumed to be a group of vitamins, has received considerable publicity, and several claims have been advanced about the tremendous growth improvements achieved through A.P.F. supplements in foods. It is generally held that the A.P.F. group, and, in particular one of its known constituents, vitamin

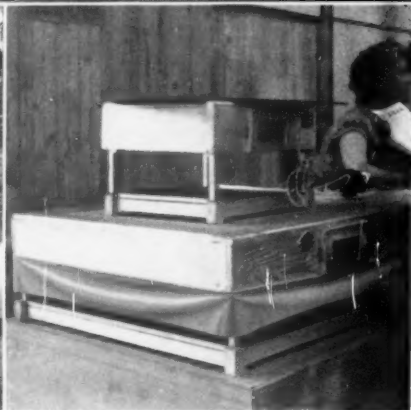


Above: General view of Exhibition with brooder in the foreground

Left: Ducks on specially constructed pond



Different stock penned in tier formation:
bottom—rabbits; middle—ducks and
chickens; top—pigeons



Electric brooder—heated board element

Photos: G. L. Burkitt



General view of the 50,000 gallon reinforced concrete ground level tank



Photos: P. O. Jolly

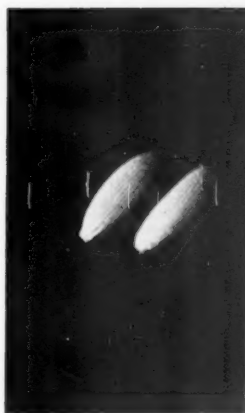
Adjusting oscillators of spray line. In foreground, the hydrant connected to the underground main



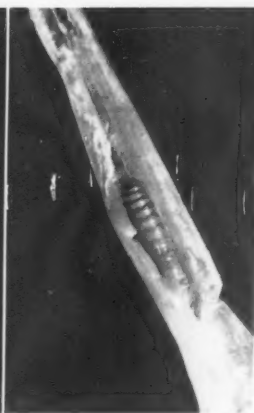
Photo : P. O. Jolly

Spray lines in use irrigating a crop of sugar beet

THE SPINACH STEM FLY (See pp. 332-4)



Eggs ($\times 20$)



Maggot ($\times 4$)



Photos : Prof. H. W. Miles

Injury by maggot

MULTIPLE REARING OF BEEF CALVES (See pp. 312-3)



Photos : C. M. Poole

- Top :* View showing method of roofing the bull yard, also the pens made from surplus materials
- Centre :* The converted bull pens
- Bottom :* Reared calves in the follow-on covered yard. Note the feeder—half an aircraft landing tyre

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B₁₂, induce improved early growth by enabling the chick to make full use of the protein in the diet. In this way A.P.F. supplements have been used with success with all-vegetable protein diets and result in growth-rates which are on a level with those obtained in diets containing animal protein. Vitamin B₁₂ is also considered essential in a diet to achieve good hatchability. In work on this subject most of the emphasis has been upon B₁₂, but a number of the papers at the Congress gave greater prominence to other growth-stimulating factors and to the modifying effect of ingredients in the food. DR. BLACK of Great Britain drew his audience's attention to the differences arising when A.P.F. supplements of varying nature were used with a diet containing groundnut meal, and when the same supplements were used with soya-bean meal. He stressed the fact that soya bean—upon which much of the American work has been conducted—was less common in the United Kingdom than ground nut, and, in the discussion on the paper he presented—"A Comparison of Different Sources of the Animal Protein Factor in Poultry Nutrition"—he suggested that A.P.F. supplements should be tested with foodstuffs which were commonly employed in this country. Dr. Black pointed out that with soya-bean meal, fish solubles gave better hatching results than fishmeal; with ground nut, the position was reversed. For chick growth, both fish solubles and antibiotic residues showed better results than fishmeal, and growth was *not* improved by additions of vitamin B₁₂.

In this last statement the audience had an indication, which was developed by subsequent speakers, that B₁₂ was not so important amongst the recently reported growth factors as had been thought. The same opinion was put more strongly in a paper on "Condensed Fish and Whale Solubles" by F. CUMBER, also of Great Britain. This author presented data to support his view that the factors in the A.P.F. group other than B₁₂ were of more importance than B₁₂ in stimulating egg production. He based this contention on the higher egg production achieved with Condensed Whale Solubles compared with Condensed Fish Solubles, although the latter carried substantially more B₁₂.

The paper by DR. COMBS of the U.S.A. also dealt with growth factors not identifiable with B₁₂. Dr. Combs's paper also referred to the Whey Factor, which appeared partially replaceable by the addition of antibiotics.

Interest in Antibiotics Two outstanding contributions were read on antibiotics—one by DR. BIRD and his colleagues of the U.S.A. on "Antibiotics in Poultry Nutrition" and the other by workers at the National Institute for Research in Dairying in Great Britain and presented by one of the authors, DR. MARIE COATES, on "Antibiotics and the Animal Protein Factor in Chick Growth". Both groups of workers agreed that a number of antibiotics such as aureomycin, streptomycin, etc., when administered orally stimulated the growth of chicks. Some divergence of views was apparent in the suggestions as to how these improvements were effected.

Dr. Bird pointed out that although improved growth was stimulated by the oral administration of streptomycin, it was greatly retarded on the withdrawal of the antibiotic from the diet. In his view it could be assumed that the drug operated by suppressing harmful bacteria or other organisms in the digestive tract. He urged this thesis by arguing that if the antibiotic synthesized some essential nutrient, it was difficult to believe that there was little or no storage of this nutrient and presumably decreasing storage when fed at higher levels. This seemed to him a reasonable deduction from the retardation of growth which followed the withdrawal of the antibiotic and

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the greater vulnerability of the chick to certain diseases after that stage. Dr. Bird did, however, suggest that the improved growth following the administration might be a combination of the suppressing action he had postulated and possibly the synthesis of some desirable nutrient.

Dr. Bird stressed that antibiotics would not prove the salvation of the many poultry-keepers suffering by a shortage of protein. Antibiotics would not convert a poor diet into a good one, and the best results with streptomycin had been produced with diets of 19 per cent protein, and when part of the protein was in the form of fishmeal. Nevertheless in his opinion the use of the antibiotic did slightly decrease the need for protein. The speaker did not consider that breeding stock would derive any benefit from the feeding of antibiotics.

Dr. Coates of Great Britain, in presenting the paper from the N.I.R.D., was more cautious than Dr. Bird in discussing the mechanism whereby antibiotics achieved the observed improvement in growth. She mentioned the belief that antibiotics might replace an unidentified factor of the A.P.F. group, but, at the same time, cast doubt on this belief because the growth of normal chicks supplied a diet carrying the A.P.F. could be further improved by the addition of antibiotics to their diet. Dr. Coates also queried the possibility of the antibiotics acting as a vitamin-like food, since no effect followed the injection of aureomycin into the bloodstream of the bird. On the possibility advocated by Dr. Bird, that antibiotics suppressed undesirable organisms in the intestinal tract, Dr. Coates stated that the bacterial counts of the gut did not support this contention, although she agreed that she and her co-workers had not investigated the alimentary tract above the gizzard.

Both the American and British speakers urged caution in the use of antibiotics by poultry farmers. They both pointed out the present limitations of our knowledge about the long-term behaviour and effect of these drugs; little was known of any influence they might have on fertility or production. Dr. Coates further pointed out that dangers might arise from the encouragement or resistant strains of disease organisms. In the view of both speakers antibiotics could be recommended for use only in the production of table poultry.

"Fibre" in the Ration At the opening session of the Congress, DR. SENIOR of the Irish Republic dealt with another aspect of poultry nutrition which is of major importance to poultry-keepers in this country—"The Significance of Crude Fibre in the Nutrition of Poultry." He pointed out that the term "fibre" as used by the chemist merely describes that part of the carbohydrate portion of the bird's food which is resistant to various chemicals. The carbohydrate group, which in this country is chiefly supplied by wheat, oats and barley, includes several groups of substances ranging from sugars and starches to cellulose. Dr. Senior stated that the chicken could digest the starch (and sugar) but none, or very little, of the cellulose and lignins. The fibre shown by the chemist was mainly cellulose and a varying amount of lignin. Between these two extreme groups of carbohydrates, i.e., sugars and cellulose, are other forms of carbohydrates which, while digestible wholly or in part by many farm animals, seem according to most writers of little or no value to the hen—yet only a small part is included as "fibre" by the analytical chemist.

Dr. Senior maintained that the present method of declaring the "fibre" content of a poultry ration was therefore of little value to the poultry-keeper; a large part of the remainder of the food might, or might not, be of value to

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the bird. Dr. Senior then proceeded to cast doubt on the value of fibre to the bird in other respects. He submitted evidence which indicated that fibre was unnecessary as a form of roughage to aid peristalsis and was of very doubtful value in combating feather picking or cannibalism.

Marketing and Economics In the Marketing and Economics section considerable interest was aroused by the papers of a number of authors describing the marketing systems of their own countries, and particular interest in the methods in the U.S.A. of increasing "consumer interest". Two papers in this section were, however, outstanding: S. R. WRAGG of Great Britain, in discussing "Some Factors determining the International Trade in Eggs", tackled his subject in an original manner and provoked lively discussion. He pointed out the instability of the international egg trade, and how rapidly the pattern could change. He criticized producers in this country for failing to employ to the full the technical knowledge now available. He considered this technical inertia of the producers in the United Kingdom to date from the 1930s, when a policy of protection was in force, and stated that the present price guarantee system did much to maintain that inertia. These views of Mr. Wragg led to a great deal of criticism from the British poultry-keepers present, who maintained that the able poultry-keeper was precluded from taking advantage of many new developments because of the restrictions imposed by limited quantities of poultry food. This point was, however, admitted in Mr. Wragg's paper, and his criticism was clearly directed to the large number of farmers amongst whom poultry-keeping is regarded as a subordinate farming enterprise and, as one speaker pointed out, the withdrawal of some farmers from poultry-keeping in recent months, consequent upon increases in food prices, appeared to sustain Mr. Wragg's contention.

A second paper of importance in this section was that on "Principles and Methods in Studies of Costs and Profits in Poultry Farming" by PROFESSOR WESTERMARCK of Finland. Some of the points in his paper were similar to those in Mr. Wragg's, but he had different arguments to urge. Professor Westermarck referred to the increasing tendency amongst governments to control directly or indirectly the prices of agricultural produce and, on this account, he considered it essential that the leaders of the poultry-keepers in the countries concerned should be able to present reliable data of the average costs of production. The speaker was extremely critical of many costings he had encountered. He also referred to the importance of the farmer fully realizing his costs of production, for Professor Westermarck maintained that although most farms carried poultry it was an enterprise very loosely integrated with other farming activities and could easily be given up in favour of something else, if the costings showed it to be unprofitable.

After dealing in detail with methods of assessing costs, Professor Westermarck suggested that a rough-and-ready assessment of profitability could be obtained in the following manner if the assumption were made that feeding costs amounted to between 50 and 60 per cent of the total production costs. With birds laying between 160 and 180 eggs per year, production costs would be approximately covered if the price per kilo (2.2 lb.) of eggs was roughly eight to nine times the cost of the same quantity of food. It is interesting to note that in this country these two factors are approximately equal on the basis of the present average price of eggs to the farmer.

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Disease The sessions on Disease had, naturally enough, several papers dealing with Newcastle Disease. They were in the main rather doleful accounts of the history of the disease in the countries of the several speakers. Amongst these was a first-class paper by DOBSON and SIMMINS of Great Britain giving a clear account of "The Introduction of Newcastle Disease by means of Frozen Poultry Carcasses" into this country. Two other British speakers—GREENWOOD and CARR—had an interesting paper on "A Possible Connection between the Rous Sarcoma Virus and Fowl Paralysis". The authors urged that the viruses causing the group of diseases described as fowl paralysis and sarcoma should be considered as a whole in any investigation. The authors demonstrated that in their work resistance to artificial infection with sarcoma virus had been achieved, but only with an increased death-rate from fowl paralysis. Clearly a reduction in the incidence of fowl paralysis would be valueless to the commercial poultry-keeper if a high death-rate was maintained through an increase in the number of birds dying from "tumours".

A paper by PIEDRAFITA of Spain also referred to fowl paralysis. The author drew attention to the possible transmission of forms of this disease by vaccines used in controlling Newcastle Disease.

Two papers from Great Britain dealt with the use of sulphaquinoxaline in combating coccidiosis; this drug has been used at a low level in mashers to control coccidiosis. One speaker—DR. HORTON-SMITH—in discussing this method, considered that the system was undesirable, and that with the present state of knowledge the drug should be used only when the disease was known to exist. DR. R. F. GORDON, in a paper concerned with the same drug, drew attention to a case of mortality amongst birds associated with the administration of sulphaquinoxaline. The evidence he presented suggested—it could be put no more strongly—that the drug might be capable of producing blood changes which, in the presence of a secondary pathogen, gave rise to a relatively high mortality rate. In view of the accepted value of the drug, the speaker urged that this matter needed further investigation.

THE SPINACH STEM FLY

MARY MILES, M.Sc.

Wye College, University of London

The economic importance of the spinach stem maggot has not yet been fully determined, but the fly appears to be widely distributed and not easy to control.

IN the late summer of 1949 Dr. Gough, Adviser in Entomology for the Eastern Province, sent me some maggots that had been found in the stems of spinach (*Spinacea oleracea*). I was unable to identify them, and as they were already dead when Dr. Gough received them, there was no means of associating them with the parent flies. From the form of the maggots it was apparent that they were closely related to such well-known insects as the cabbage root fly, the onion fly and the bean seed fly. Search in available literature revealed that only three Anthomyid flies were known

THE SPINACH STEM FLY

to occur on spinach—the mangold fly (*Pegomyia betae* Curt.) which makes blister mines in the leaves, the bean seed fly (*D.cilicrura* Rond.) which has been reported from the United States as feeding in the terminal shoots, and a saprophytic species (*Pegohylemyia fugax* Mg.) which is associated with rotting tissue of spinach brassicas, oats and other crops. The maggots of these species differed from those which had been found in the stems of spinach from the east of England.

In the spring of 1950 spinach for seed was grown at Wye College. A search in the crop during the last week of May showed that stem maggots were present. Flies were reared from them and were identified by Dr. van Emden of the British Museum (Natural History) as *Hylemyia echinata* Ség. The occurrence of the flies on this crop of spinach was of considerable interest because it was far from gardens and allotments and, so far as was known, spinach had never been grown there previously. Another row of spinach was sown in the same field in the late summer. More maggots were found and flies emerged from them in late September.

In the spring of 1951 spinach seed was sown on a small observation plot about half a mile from the site where the maggots occurred during the previous year. On May 28 eggs were found on the leaves, and the maggots that emerged were recognized as those of the spinach stem fly, *H. echinata*. It was then possible to observe the life cycle and the damage to the plants.

Life History and Damage The eggs were laid singly on the upper side of unfolding leaves, usually about the middle in the trough formed by the midrib, but sometimes on a lateral vein near the leaf base. They did not adhere to the leaves like those of mangold fly which were present on the under side at the same time, and heavy rain sometimes washed them into the heart of the plant. Spinach fly eggs are white with broken longitudinal ridges very similar to those of the cabbage root fly, but the pair of stout ribs arising in the micropylar ring extended along the concave surface for only $\frac{1}{4}$ – $\frac{1}{2}$ of the length (Fig. 1, p. iii of the art inset). The eggs are approximately 0.9 mm. long.

Eggs collected on May 28 hatched three days later. The maggots immediately tunnelled into the leaf tissue, where they made small blotch mines extending a short distance on both sides of the veins on which the eggs had been deposited. Later they entered veins or midribs and tunnelled to the junction of the leaf with the main stem. Pupation took place in the soil or, occasionally, in the feeding tunnel.

Fully grown maggots are about $\frac{1}{4}$ inch long, and the fore-part of the body appears to be ringed with black because discoloured and coagulated sap adheres to the fine spicules on the skin of the front parts of the segments (Fig. 2).

At pupation the skin turns brown and puparia 4 mm. long are formed. Flies emerge in 2–3 weeks. They are 4–5 mm. long and yellowish-grey, the males being darker than the females. The life cycle is completed in 5–6 weeks and there is time for three or four generations in the period of activity, which extends from April–May to September–October.

Injury by the spinach stem fly usually consists of a small blotch mine extending on both sides of the midrib near the middle of the leaf. The area affected is generally less than $\frac{1}{4}$ sq. inch, and is pale green at first but later becomes dark brown. The leaf stem may show no sign of the presence of the maggot until it makes its exit hole at the base, but more often growth causes the damaged stem to split and expose the discoloured feeding tunnel

THE SPINACH STEM FLY

(Fig. 3). When the maggot enters a growing leaf the damage to the midrib causes the leaf to bend backwards at a right-angle, and shrivelled discoloured tissue can then be seen on the under-surface at the point where it bends. Attacked plants often show severe damage and discoloration to the terminal bud. The injury is not conspicuous, but once it has been seen and recognized it is not likely again to be overlooked.

The economic importance of the spinach stem fly has not yet been investigated. Farmers growing spinach under contract are aware of the infestation of the crops by this insect but have no details as to the extent of the injury. In a row of spinach (approximately 6 yards long) grown for observation in May, 1951, almost every plant was attacked.

Control Difficult Suitable control measures against spinach stem flies will be difficult to devise because of the limitations imposed by the nature of the crop and the habits of the insects. Spinach is usually sown and harvested in spring, only 6-8 weeks intervening between sowing and cutting, and almost the whole of the plant is marketed.

The peak period of egg-laying by the spring generation of spinach stem flies occurs in warm sunny weather in April-May, the time when the crop is making its growth. When egg-laying is early the infestation has a chance to develop fully before the spinach is cut and many maggots are found in the crop. But when egg-laying is late, as in 1951, the crop is harvested before the eggs hatch or before the maggots have attained a size at which they are readily seen.

The maggots are exposed on the surface of the leaves for only a short time before they penetrate the tissue and pass beyond the reach of insecticidal treatment. The use of a dust containing DDT, BHC, nicotine, derris or lonchocarpus appears impractical because the interval between dusting and harvesting would be short and the crop would be contaminated or tainted by the treatment. The use of a spray containing nicotine, derris or pyrethrum deserves consideration, but careful timing would be necessary if good results were to follow this treatment.

Distribution The maggots first brought to my attention were found in spinach grown in the east of England. The insects were observed at Wye in the first crop examined (May, 1950) and again on spinach in the same field in August and September (1950). In early May, 1951, spinach was sown at Wye about $\frac{1}{2}$ mile from the site of attack in the previous year and again the plants became infested. Maggots were also received from Goudhurst, Kent. When the effects of maggot attack on leaves and terminal buds could be seen in plants under observation, I remembered that I had seen similar injury in spinach from a garden near Bristol. These scattered occurrences suggest that spinach stem flies may be widely distributed.

A fuller account of the spinach stem fly is being prepared for publication elsewhere, but the details given here will serve to draw attention to an insect which is troublesome in spinach grown for canning.

BRAZING, SOLDERING, AND WELDING

H. J. HINE

Ministry of Agriculture and Fisheries

Broken implement parts should not be discarded hurriedly; they can often be repaired by the farm mechanic or blacksmith.

MUCH of the work of a blacksmith and of a farm mechanic consists of joining two pieces of metal. Sometimes the joint will be made by nuts and bolts, sometimes rivets will be used, but in these days of getting things done quickly, welding, brazing and soldering are being used increasingly.

Welding is not a new process. The blacksmith who heats two pieces of steel in the forge and then hammers them together on the anvil is welding. An oxy-acetylene torch or an electric current is a convenient way of providing local heat, and these methods of heating make it easier to introduce a flux to retard oxidation and to remove scale; they also allow new metal to be introduced into the join. This new metal comes from the "weld rod".

The introduction of a new metal, usually different from that of which the implement is made, is used also in brazing and soldering. In soldering, a metal is used which fuses at a very low temperature, and the heat from a small blow-pipe or from a heated soldering iron is sufficient to make the solder melt and adhere to the two pieces that are being joined.

Brazing makes the join by using a mixture of copper and zinc, and sometimes of silver as well. The melting point of this mixture is fairly high and a blow-pipe has to be used for brazing, but the difference between soldering and brazing lies not only in the melting point of the added metal but also in the technique. The articles themselves are heated to a dull red when brazing is to be done. Soldering can be done with just the local heat which melts the solder itself, though a little general heat is needed for solder "sweating". Fluxes have to be used in both soldering and brazing.

Welding, whether by oxy-acetylene gas or by electricity, can soon be learnt and practised by farm mechanics, but for many farmers the most useful knowledge they can have about welding is information about its possibilities. For example, when a part of a machine breaks it is useful to know whether the broken parts can be taken to a blacksmith or motor engineer and successfully repaired by welding, or whether a new part must be bought. Broken wheels, brackets, and control levers of ploughs can be successfully repaired; so can broken knife-backs in mowers. Broken gear teeth and brackets and other castings from cultivators and drills can be welded satisfactorily. Many tractor parts, even cracked cylinder heads and torn crankcases, can be repaired by skilful welding. A point to be remembered when parts of broken implements are to be welded is that all the pieces should be found and taken. They will not always be used in the repair, for broken gear and sprocket teeth are more easily repaired by building up the broken portion with new metal, but they will be a good guide to the welder as to shape.

Steel is not the only metal that can be welded satisfactorily, nor is the joining of pieces of metal together the only function of welding.

Fluxes and weld rods have lately been developed for many metals other than steel. Aluminium and copper dairy utensils can be repaired by this method. Die castings having a zinc base, such as the bodies of tractor carburettors, can be repaired, and so can most alloys.

BRAZING, SOLDERING AND WELDING

Welders are able to apply hard-facing weld deposits to the wearing edges of some implements. Not all parts are suitable for hard facing and, in any case, the procedure is worth while only where implements are working under conditions where the wear is great ; but cultivator points, subsoiler points, steel plough-shares, track units of track-laying tractors, and wheel spuds are eminently suitable for hard facing. Generally, it is as well to have the new parts treated before they are used at all.

Steel plough-shares, when worn or broken, can be repaired by welding; moreover, a hard facing, applied to the wearing edges before the share is put into service, will lengthen its life considerably.

Gas welders often use their oxy-acetylene torches for bronze welding which is a perfectly reliable method of repair. There is, however, a fundamental difference between this and fusion welding. Fusion welding, as the name truly describes, is a union of the two parts into a homogeneous whole. The filler rod is of similar composition to the metals being joined. In bronze welding, a foreign metal is used in the join, and the result is a heterogeneous joining of the two metals, though that is no reason why the join should not be very strong. Lower temperatures are needed, and the risk of distortion is less.

So much thought has lately been put into this technique of joining metals together that a farmer should never throw away any broken implement part until he is quite sure that it could not be made sound again by a welder.

A CENTURY'S CHANGE ON AN OXFORDSHIRE FARM

NIGEL HARVEY, M.A.

A wages-book bearing the date of 1851 came into the hands of the writer recently, and evoked some interesting reflections on the many changes that have come to the land during the past hundred years.

AT first sight the old blue wages-book of the Manor Farm of this central Oxfordshire parish reflects in striking fashion the continuity and stability of English rural life ; the grandfather of the present occupier compiled it in 1850-51 and his grandson, still farming the same land, has lent it to the writer. To the casual eye the farm has changed little in the last hundred years; indeed, on the map it has not changed at all. The boundaries still contain 180 acres, for the most part heavy clay ; the field divisions have not altered since they were established by the forgotten Enclosure Commissioners of George III's time ; and the general outline of the farmstead remains the same. But this is a purely superficial view. The old wages-book also reflects farming change and development, for the weekly analysis of the farm's routine in the days of the Great Exhibition takes us back to an agricultural system very different from the one we know today. Crops and stock, equipment, policies and methods have all altered and a comparison of the farm then with the farm now illustrates the thoroughness and purpose with which the rural community, generation by generation, adapts itself and its tools to the changing demands of each successive age.

A CENTURY'S CHANGE ON AN OXFORDSHIRE FARM

For one thing, even the character and fertility of the land have been modified by the action of the farmer. The grandfather, a hundred years ago, could have deep-drained his fields with brushwood, horse-shoe tiles or even the new cylindrical tile-pipes, though it was only in 1843 that Parkes the engineer held aloft the first modern machine-made drainage-tile and cried in triumph, "With these we can drain all England". And he certainly maintained his ditches, spending 26 man-days on ditching and draining in the winter months. But he could not mole-drain, for this technique, though known in a crude form, did not become a normal farm operation till 1859, when Fowler adapted to steam-tackle the mole-plough which he had patented in 1850. His grandson, however, mole-drains by tractor every seven years as part of his routine of cultivation. Again, the soil is now treated differently, for the grandson has a wider choice of purchased plant-foods. Peruvian guano, ground bones, superphosphates and Chilean nitrates were all available a century ago, while a waste-product of the gas-works was just coming on the market under the name of "sulphate of ammonia," but potash was not mined till the 1860s and the basic slag did not come to the farm till the 'eighties. On the other hand, the last decade has painfully reduced another source of plant-food, the residues of purchased cake, and the present farmer, like his predecessor, looks to his fields rather than to his merchant for his fodder.

Supremacy of the Dairy Cow

More obvious, however, is the change in policy. Today the farm is essentially a dairy farm, carrying a milking herd of forty head and some sixty-five followers, the breed being chosen for their milk-producing capacity. Indeed, before the war, most of the farm was permanent pasture, and though today nearly 160 acres are under the plough, the rotation of four years ley and three years corn or roots is designed primarily to produce stockfeed. Liquid milk, in short, is the cash crop and all field crops are subservient to the dairy cow, though in war-time room was found for 30 acres of wheat and even a few acres of sugar beet, the latter no more than a name to the English farmer of 1851. But a century ago corn was king, nearly one arable acre in four was under wheat and the average Englishman still ate home-grown bread. It is probable, therefore, (the exact figures are unknown, as this was before the days of the Agricultural Returns) that most of this farm was cropped on some variation of the four-course shift, with wheat, to which the soil is well suited, as the main source of farm income. Milk, it is true, was also produced, sixteen cows being kept, but it was made into butter instead of being marketed in liquid form; for evil communications do more than corrupt good manners—they also render impossible the sale of milk to distant towns which, in early Victorian England, still relied on the "urban cow-keepers" for their milk. It was the development first of the railways, then of the milk lorry, coupled with higher sanitary standards in the cities, that made the modern dairy industry possible. But this came later; in 1851 the udder did not seriously challenge the wheatsheaf.

In more general terms, the farm in 1851 was considerably less specialized than it is today. The modern occupier concentrates on milk, carrying no sheep and only a few pigs, though he has recently started running a few hundred head of poultry, including turkeys. But his grandfather followed the mixed farming traditions of his time and ran a flock of arable sheep on the rootbreak of his rotation—the accounts refer to the making of the hurdles in the winter months—while an appreciable number of pigs fattened on the general waste of the farm, including the invaluable skim milk produced by

A CENTURY'S CHANGE ON AN OXFORDSHIRE FARM

the butter-making. Indeed this Oxfordshire farm was very typical of its time.

Labour—Then and Now All this is reflected in the labour demands and resources of the farm, and it is here that the old wages-book is most instructive. The present staff consists of the farmer and three men, and this, allowing a six-day week and two weeks' absence per man per year, gives a total of 1,200 man-days a year. Of this, one may assume that the stock takes over half, leaving, say, 500 for the arable land. This labour force is fairly constant throughout the year. The farm has little need of casual labour because the two tractors it carries allow each man to "extend" his working abilities to meet the shifting demands of the seasons. But in 1851 things were very different. The farmer, of course, does not appear in his accounts, neither does the stockman, nor any assistant he may have had. The farmer's wife, who almost certainly did much of the dairy work, is also absent. Yet, even so, the farm absorbed a recorded total of some 1,100 paid man-days a year—and, it must be remembered, working hours were longer then than now. The figure is not, perhaps, wholly unexpected but its analysis is interesting.

About 400 man-days, over a third of the total, went on dung-spreading, ploughing and the various cultivations necessary for the preparation of the seedbed. Drilling, however, required only 21 man-days—and the fact that some, at least, of the seeds were drilled shows that this farm was more advanced in its methods than many, since at that time, over a century after the death of Tull, the drill was by no means a universal tool. A staggering amount of labour was spent on hand-hoeing wheat and beans—no less than 154 man-days, or, more accurately, man-and-woman-days, since this was one of the tasks of the cheap and plentiful gang labour of those times. Hand-hoeing was, of course, more expensive than horse-hoeing, but it was also more efficient and the farmer of the 'fifties set a high value on clean fields.

Haymaking, too, was a heavy item (some 130 man-days), for the mower, the swath-turner, the horse-rake, the hay-sweep and the elevator were still in the future and the crop was cut, turned and stacked by hand. And finally came harvest (180 man-days in all), when a gang of sicklemen and binders descended on the cornfields for "the crown of the year". Yet already the ancient ritual was threatened. Bell's machine, it is true, had achieved only a limited success but in McCormick's famous reaper, one of the most discussed exhibits in the Great Exhibition, the intelligent farmer could clearly see the shape of technical things to come. After harvest came threshing, though not, as yet, mechanical threshing, for this farm still used the flail. But the record makes clear the advantages of this laborious method; the farmer had no need to collect a gang of half-a-dozen men from other jobs, nor was he dependent on the weather. His flailers worked, in all, some 170 days in the course of the year and, except at harvest time, there were few weeks when somebody did not put in two or three days "swingling" on the hard floor of the barn.

Most of the flailing took place in the winter-time; indeed, it was the main source of employment for many labourers in the months between the end of harvest and the beginning of the spring cultivations. It is significant that in another part of Oxfordshire, as late as the 1870s, at least one farmer thought it wise to sleep some nights in his barn, near his new drum, with a dog on one side of him and a gun on the other. This shortage of winter work illustrates the seasonal nature of the old system of arable farming which is so clearly shown in the wages-book. Between October and April

A CENTURY'S CHANGE ON AN OXFORDSHIRE FARM

it was rare for more than 20 man-days to be recorded per week, but between May and September it fluctuated between the twenties and thirties, running well into the forties at harvest time.

Equally interesting are the minor items recorded in this account book, such as the 3d. a day paid to the "crow-starving" boy, and the charge for passing a turnpike on the road to market, while the two man-days spent on brewing remind us that the farm household a century ago was largely independent of shops. Probably the farmer's wife made her own bread, though this, of course, does not appear in the accounts. More striking, as evidence of rural change, are certain curious entries which puzzle the modern reader; indeed, it sometimes takes no small amount of enquiry to understand matters which in 1851 were a normal part of agricultural routine. There is, for instance, a reference to "paddling"—a paddle being a special type of hoe used in weeding broadcast corn—and it is a sign of the changed times that this word is now unknown to the local villagers. Then, again, what are we to make of this "stubble-cutting" which required 31 man-days in the course of the year? It is not easy for us mechanized moderns to picture the harvest in the days before the reaper, when the sicklemen cut the corn high and the tall stubble was later cleared piecemeal, as required, for fodder or litter.

Farm Income Available information does not, unfortunately, allow any direct comparison between the income and expenditure of the farm then and now, but it is possible to give a rough estimate of the proportion of the main items. In 1851, of every £100 which came to the farm, about £50 came from the sale of corn, £15 from the sale of pigs, £13 from the sale of sheep, £12 from the sale of butter and £10 from the sale of cattle. In short, field products and stock products were about equal in value. But today probably some £80 out of every £100 received comes from the sale of milk while the additional sale of calves, old cows, pigs and poultry reduces the cash earnings of the arable land to a very small proportion of the whole. Equally significant, perhaps, is the change in the proportion between the rental value of the farm and the wages bill. In 1851 it would have rented at, say, £200 a year, while today the figure might be £350. But a century ago the total annual wages-bill came to £110, whereas the total for the three full-time men on the farm and for occasional casual labour now runs well into four figures. Thus wages on this farm have risen from just over half the rent to more than three times the rent—and they purchase 900 working days a year as against 1,100. So greatly have the economic times changed, so far has the balance of factors of production shifted.

Of course, one swallow does not make a summer, neither does one brief case study constitute a trend. Further, this Oxfordshire Manor Farm is in no sense an average farm. Such abstractions exist only in statistics and, in any case, the standards of management of this particular farm certainly are, and probably were, well above average. Yet it is a fairly representative type of holding and its story at once summarizes and reflects many of the great changes which have come to British agriculture in the last hundred years.

AGRICULTURAL CONTRACTORS

THEIR NUMBERS AND EQUIPMENT

FARM mechanization as we know it and think about it today can be said to have started in 1939. On an average about three combined harvester-threshers and 800 tractors were at work in each county that year. This year the figures are 250 combines and 5,000 tractors.

It would be rash to venture an opinion as to the level that will be reached for these or indeed of any other farm machines during the next decade. And it would be rasher still to attempt any forecast of the extent to which farmers will be able or willing to buy machines for their own exclusive use and to what extent they will be prepared to depend, as an efficient, convenient and economical arrangement, on the equipment they will be able to hire from others—County Committees, neighbours or contractors. The pattern, so far as the Committees are concerned, is emerging fairly clearly : here the plan is to put the service on a sound financial footing and to limit it to work which cannot be done by other means.

It is very much more difficult to see what the eventual position of the private contractor is going to be. No doubt he will have an important part to play in bringing to a large class of farmers the benefits of special and expensive equipment which it would be uneconomic for them to buy for themselves.

The Machinery censuses taken biennially from 1942 to 1950 provided some firm and interesting information as to the trend of one aspect of the agricultural contracting service—that provided by whole-time contractors:

Table 1
Numbers of Certain Machines owned by Whole-time Agricultural
Contractors in England and Wales

MACHINE	1942	1944	1946	1948	1950
Agricultural Tractors :					
Crawler	220	320	360	460	370
Wheeled	1,560	2,250	2,600	3,810	2,600
Corn Drills	200	270	290	380	240
Combined Grain and Fertilizer Drills	20	60	70	140	130
Mowers	500	640	710	1,110	790
Binders	460	710	780	1,050	680
Combined Harvester Threshers	20	40	60	150	220
Threshers	1,160	1,340	1,540	1,800	1,100
Pick-up Balers	n/a	n/a	160	110	150

But these figures present an incomplete picture of the resources of contractors. At the beginning of 1950 for every whole-time contractor there were more than four contractors who farmed on their own account ; these ranged from the man whose farming was by far the most important part of his activities and did little casual work for others to the contractor in a big way whose farming was merely a sideline.

AGRICULTURAL CONTRACTORS : NUMBERS AND EQUIPMENT

At the 1950 census 5,700 occupiers of agricultural holdings indicated that they were registered under the Agricultural Contractors Orders made in 1940. (These orders have now been revoked.) There is no really satisfactory way of assessing how much of their equipment was available for work on other holdings. The best that can be done is to apportion their equipment between the two kinds of work (their own and other people's) on the basis of the proportion of the total area they farmed in each county to the total area under cultivation.

Table 2

Agricultural Machinery Available for Contract Work in England and Wales
(January, 1950)

	Available for Contract work by part-time Contractors	Owned by full-time Contractors	Total Availability for Contract Work
Agricultural Tractors :			
Crawler	640	370	1,010
Wheeled	4,480	2,600	7,080
Corn Drills	300	240	540
Combined Grain and Fertilizer			
Drills	600	130	730
Mowers	70	790	860
Binders	1,300	680	1,980
Combines	840	220	1,060
Thrashers	2,130	1,100	3,230
Stationary Balers	1,300	760	2,060
Pick-up Balers	560	150	710

Table 3 (pp. 342-3) shows the number of contractors—whole-time and part-time separately—and the number of tractors (the king-pin of farm mechanization) owned separately and jointly in each county, excluding in the case of the part-time contractor an estimate on the basis described above of the number of tractors required for working his own land.

All the figures used in these notes are "net", that is, they have not been raised to allow for any contractors—part-time or whole-time—who did not for one reason or another make a return.

Farm contracting has been very fluid since the war. Many enthusiastic and energetic young men have been attracted to this field, although some, because of the lack of remunerative work between the busy seasons and slow payments for work done, have been forced to retire. There is, however, a hard core of established enterprising contractors who are able to offer their services to farmers at attractive rates.

Table 3
No. of Contractors and Tractors owned by them and available for Contract Work in England and Wales (January, 1950)

ENGLAND	CONTRACTORS		TRACTORS AVAILABLE FOR CONTRACT WORK					Total Tractor availability
	Whole-time No.	Part-time No.	Crawlers		Wheeled			
			Whole-time contractors	Part-time contractors	Whole-time contractors	Part-time contractors		
Bedfordshire ..	4	90	6	36	4	9	55	
Berkshire ..	16	51	6	9	40	24	79	
Buckinghamshire ..	30	81	5	7	66	50	128	
Cambridgeshire ..	19	64	14	40	41	117	212	
Isle of Ely ..	4	52	1	25	10	59	95	
Cheshire ..	46	160	2	3	97	168	270	
Cornwall ..	17	143	1	4	24	93	122	
Cumberland ..	22	58	1	—	54	58	113	
Derbyshire ..	38	187	11	—	56	150	217	
Devon ..	30	328	1	16	53	233	303	
Dorset ..	10	52	2	3	24	52	81	
Durham ..	14	78	—	2	17	63	82	
Essex ..	47	164	34	48	111	98	291	
Gloucestershire ..	34	131	25	4	90	70	189	
Hampshire ..	56	133	36	10	96	128	270	
Isle of Wight ..	2	17	2	3	8	17	30	
Herefordshire ..	16	150	6	6	56	114	182	
Hertfordshire ..	14	45	11	9	24	32	76	
Huntingdonshire ..	5	34	8	22	4	—	34	
Kent ..	21	146	11	27	59	158	255	
Lancashire ..	57	156	1	6	137	162	306	
Leicestershire ..	31	90	6	18	64	79	167	
Lincs (Holland) ..	20	60	13	21	47	17	98	
Lincs (Kesteven) ..	9	52	21	24	20	44	109	
Lincs (Lindsey) ..	33	111	38	43	67	115	263	
Middlesex ..	3	10	—	—	3	13	16	
Norfolk ..	79	312	19	55	175	242	491	
Northamptonshire ..	24	94	3	14	44	92	153	
Soke of Peterborough ..	—	8	—	—	—	1	1	
Northumberland ..	15	72	—	2	21	74	97	

Nottinghamshire	..	12	61	11	22	15	50	98
Oxfordshire	..	24	54	1	6	59	70	136
Rutland	..	1	14	—	1	70	107	12
Salop	..	38	153	3	5	48	10	185
Somerset	..	18	260	1	14	70	149	212
Staffordshire	..	30	146	3	7	83	129	222
Suffolk, East	..	10	105	19	23	33	84	159
Suffolk, West	..	3	51	1	24	7	27	59
Surrey	..	16	37	—	—	22	65	87
Sussex, East	..	21	146	3	1	55	109	168
Sussex, West	..	9	62	3	—	23	35	59
Warwickshire	..	21	161	—	20	53	119	195
Westmorland	..	11	10	3	—	39	14	39
Wiltshire	..	20	78	11	3	62	23	99
Worcestershire	..	18	122	10	21	48	75	154
Yorks (East Riding)	..	41	72	2	11	75	91	179
Yorks (North Riding)	..	57	161	2	2	116	131	251
Yorks (West Riding)	..	71	148	10	20	120	171	321
TOTAL ENGLAND	..	1,137	4,970	365	637	2,427	3,991	7,420
WALES								
Anglesey	..	2	53	—	1	3	41	45
Breconshire	..	3	12	—	1	5	8	14
Carmarvonshire	..	22	69	1	—	29	54	84
Cardiganshire	..	1	49	—	—	2	28	30
Carmarthenshire	..	6	109	—	—	8	37	45
Denbighshire	..	16	92	—	2	21	74	97
Flintshire	..	9	55	—	—	19	54	73
Glamorganshire	..	5	51	—	—	8	26	34
Merionethshire	..	1	21	—	2	2	20	24
Monmouthshire	..	3	43	—	—	8	22	30
Montgomeryshire	..	7	71	—	—	12	62	74
Pembrokeshire	..	30	96	—	—	47	50	97
Radnorshire	..	8	26	—	2	9	14	25
TOTAL WALES	..	113	747	1	8	173	490	672
TOTAL ENGLAND AND WALES	..	1,250	5,717	366	645	2,600	4,481	8,092

FARMING AFFAIRS

Farming Cameo:

12. Gwyrfai, Caernarvonshire With mountain and sea in close proximity, this district is typical of the county. A comparatively narrow fringe of level land, which rises gradually to a height of about 500 feet, followed by a steeper gradient of 2,000–3,500 feet at the highest point, skirts the 18 miles of coast.

The soil has been formed from igneous material and glacial drift, resulting in an area of well-drained, light loams, interspersed with strips and pockets characterized by impeded drainage. There is a natural deficiency of lime and phosphate. A distinctive feature is the prevalence of rock which makes much of the semi-upland and large areas of rough grazing unploughable.

Slate quarrying is an important industry in the area, and a considerable number of quarrymen occupy smallholdings carrying one or two cows. There are 1,600 holdings covering an area of 64,000 acres, more than half of which is rough grazing. In addition, there is an area of common land on the mountain. Excluding the rough grazing, only 2 per cent of the farms are over 100 acres, 6 per cent from 50 to 100 acres and 18 per cent from 20 to 50 acres, leaving 74 per cent with under 20 acres of crops and grass. Farms at the foot of the mountains and a number of the lowland farms have large sheep-walks.

The rainfall varies from 40 inches near the coast to more than a 100 inches at the highest points, so that the district is better suited to grass than tillage crops. Oats are by far the most important arable crop and there is a fair acreage of dredge corn; very little pure wheat is grown. Kale has become popular in recent years. Some farmers are showing the way to increased production by intensive management of grassland, and two farms have acquired small, grass-drying plants. Substantial development has occurred in silage-making, several farmers having constructed good pits where mostly cereal-legume crops are conserved.

Considering the nature of the land, the area is comparatively well stocked, with 17,000 head of cattle, 70,000 head of sheep, 1,600 pigs and 90,000 poultry. Shorthorn and Welsh Black are the principal cattle breeds, though the Ayrshire has made an appreciable incursion in recent years. Milk production has trebled since 1939 and about 40 per cent of the herds are now attested.

On the high land the only breed of sheep is the Welsh Mountain, and much attention has been devoted to the improvement of the flocks by judicious selection of rams. The Welsh Mountain Sheep Society greatly fosters this movement by arranging for the inspection of flocks and the holding of annual sales of approved rams. Draft ewes from the lowland areas are crossed with the Border Leicester to produce a very useful half-bred ewe for further crossing with the Down breeds. Wintering hill sheep is a common practice on many of the semi-lowland farms and at present prices brings a good income.

Much of the area is of a marginal character and a considerable acreage has been reclaimed during the last ten years. Many of the hill farms are availing themselves of the facilities under the Hill Farming Act to bring about much-needed improvements.

W. E. Lloyd,
Assistant County Agricultural Officer

FARMING AFFAIRS

Safe Tractor Driving Driving a tractor ought to be a very safe occupation ; but there are more accidents than there need be. When bulls and other animals are to be looked after there is always a certain amount of risk because their actions are unpredictable, but a tractor has no temperament and if it is handled with skill it will play no tricks.

Knowledge and thought can forewarn against any danger likely to arise. For example, if the driver is wearing rubber boots and there is mud on the platform and control pedals of the tractor, he should remind himself that he must step very carefully when he climbs on to the tractor, and that when he works the clutch or brake his foot must be squarely on the pedal so that it does not slip off.

In the same way, his knowledge of the science of mechanics will tell him that a wheeled tractor has, necessarily, a high centre of gravity, otherwise it would be of no use for row-crop work nor for deep ploughing. He will know, therefore, that it is dangerous to attempt extreme sideling work, and that there is a danger of the tractor toppling sideways when it is driven too near the crumbling side of a ditch.

Another cause of overturning is the use of one back wheel brake instead of both. Independent brakes, one on each rear wheel, are provided to help the tractor to turn when it is running slowly on a narrow headland, but to check the tractor when it is running fast on the roadway or from field to field the brakes must be applied on both rear wheels simultaneously. If only one rear brake is applied it may swing the tractor so sharply to one side that it will overturn.

Thought will tell the driver that a tractor, with its large engine and low gear ratio, moves almost irresistibly. Therefore it should be allowed to start moving only when the operator is in a position to assume complete control over it. Before any attempt is made to start the engine of a tractor either by hand crank or electric starter, the operator must satisfy himself that the gear lever is in its neutral position, lest the tractor should move off when the engine starts. Most cases of the driver being run down by the tractor occur, however, not when the engine is being started but when implements are being connected to the tractor. The driver must remain on the seat of the tractor while he is backing the tractor towards the implement. He should never try to work the clutch while he is off the tractor. If a second man is available he can hold the hitch of a trailed implement ready for the clevis to engage the tractor drawbar, or can help to engage the arms of a unit attachment implement, but this second man must not kneel or crouch at the job, or he may himself get run over. He must be on his feet, ready to move away quickly if the tractor comes back too far.

Power-take-off drives should generally be stopped before the driver dismounts from the tractor, and at any rate no adjustments to implements should be attempted until it is quite certain that the power drive is disengaged.

Guards and shields on power-take-off shafts should always be firmly in position while the outfit is at work.

When the cap is being taken off a hot radiator, for water to be added, the operator should stand well back so that his face is not over the opening. Steam or a spray of boiling water may gush out of the radiator.

Broken wrists when starting tractors can be prevented if the driver will be content only to pull the starting handle up and not to try to swing it. He can keep his thumb lying alongside the fingers with the handle lying in the cup of the palm. Then, if the engine should back-fire, its rotation will throw

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his hand away and his grip of the handle will be lost ; whereas, if the thumb is twined round the handle it is almost impossible to let go.

When the tractor engine is running in the shed, the doors should be opened to allow the poisonous exhaust fumes to escape.

Deeper knowledge of the working principles of the tractor and its implements will soon bring a safe and interesting routine of operation.

The Cheviots – Sheep Country The austerities of farming in the Cheviots is touched upon by Mr. F. R. Banks in an excellent Batsford book* published this year. He cites, as example, Uswayford, one of the last farms this side of the Scottish border. It is 3 miles from the nearest road (it was 8 miles before the road was extended up the Coquet), 4 miles from the nearest school, 10 miles from the nearest inn and the nearest shop (though groceries are actually brought from Wooler, 25 miles away, to Barrowburn, at the foot of the Usway Burn, and carted up thence by the farmer himself), 12 miles from the nearest telegraph-office, 20 miles from the nearest regular bus service, and 35 miles from the nearest accessible railway station. Some remote farms can be reached only by footpath or unmade cart-track.

Conditions during the winter can be severe indeed, and the risk of losing large numbers of sheep very real. "Some sheep are almost bound to perish in drifts of snow each winter, despite the valiant efforts of the shepherds, who may spend days in finding them and digging them out ; and others will inevitably succumb to the sickness caused by exposure to the damp : sheep can endure practically any amount of cold so long as the weather be dry, but soon go under when it turns excessively wet. Others are affected by snow blindness, or 'staggers,' as it is called." Outlying farms may be snowed up for several weeks ; one was "completely cut off from the outside world for about 17 weeks in the severe winter of 1940–41, and for about 11 weeks during the very bad blizzard of early 1947".

The two breeds mainly to be seen are the native Cheviots on the grassy hills, and the Blackface on the coarser grasses and heather. Some crosses of Cheviot rams with Blackface ewes, which some farmers think produces a more hardy strain than either of the breeds pure, are also seen. The flocks, ranging over thousands of acres, may be of 2,000 or more, which keep the shepherds—and their dogs—busy.

"No one who has walked (and preferably, also, slept out) on the hills, or who has fished the clear burns, will forget the harsh, guttural bleating of the sheep in the evening, as the flock pursues its way to the heights (the path of a sheep is naturally upward), or in the early morning when the shepherds come out to 'gather,' driving the flock, with the aid of their clever cross-bred dogs, down again to the fresher, sweeter grass of the valleys." This is indeed sheep country, and Mr. Banks does not put too fine a point on it when he says that from the economic point of view, sheep are the only reason for the existence of the Cheviots !

* F. R. BANKS. *Scottish Border Country*. 12s. 6d.

FARMING AFFAIRS

Soil Fertility in South Australia: The Role of Legumes and Fertilizers

From all parts of Australia there is evidence of changing levels of soil nitrogen and of declining fertility, but there is evidence, too, of a build-up of fertility under clover pastures top dressed with superphosphate. This was stated by Professor Teakle, Dean of the Faculty of Agriculture of the University of Queensland, at a recent conference at the Hawkesbury Agricultural College of the New South Wales Agricultural Bureau. Professor Teakle said that millions of acres of land in southern Australia were now vastly richer than they were fifty years ago, as the result of clovers and suitable fertilizers. It had been found that subterranean clover, lupins and trefoils maintained soil fertility, built up crop yields, and improved the composition of the crops. Legumes were important in any system of farm management.

Nitrogen content, he said, would decrease under a wheat fallow system, but would be stabilized at a high figure when clover pasture was introduced, the figure probably being higher than for virgin soil. He did not condemn a good fallow, but said that it must be combined with a farming system of balanced fertility. On such good soils as those of the Wimmera (Victoria) and the Darling Downs (Queensland) loss of fertility would be slow but inevitable. Some farmers had proved that a change in methods from wheat-fallow-wheat to soil-building crops, such as subterranean clover, could convert an impoverished farm into a profitable proposition. A 20-bushel crop of wheat took 20 lb. of nitrogen per acre from the soil. A cow yielding 500 gallons of milk took a lot more, and those losses must be replenished.

"There is alarming evidence of declining soil fertility on millions of acres of arable land—chiefly land under wheat," said Professor Teakle. "Research work on soils from many parts of the Australian wheat belt points irrefutably to substantial loss of nitrogen after a few decades of cultivation. Losses as high as 50 per cent have been recorded, and many range between 10 and 30 per cent. This nitrogen loss means deterioration in the structure of the soil, lowered capacity to absorb water, and, frequently, disastrous soil erosion. The best known method of maintaining soil fertility in general agricultural systems is the 'ley' system, in which crops, pasture and stock are integrated into a permanent and profitable agricultural practice. As a result of investigation on the effect of clover pastures on soil nitrogen at the Rutherglen Research Station in Victoria, Penman concluded that a good, vigorous sward of subterranean clover could add as much as 200 lb. of nitrogen a year. Taking good and bad years into account, an annual increase of 50 lb. at least could be expected under clover ley."

Industrial Fibres The Commonwealth Economic Committee's review of Industrial Fibres,* traces the post-war trends in production and consumption of the chief fibres, and serves as a background to the current position of general scarcity. In 1949-50 the output of every fibre except jute increased, and a considerable surplus of cotton, which normally accounts for over half the total production of fibres, was anticipated for 1950-51. In view of this, the area under cotton in the United States, was restricted in 1950-51, but the American crop was smaller than had been expected, and exports are at present restricted on a quota basis. Despite increases in many other countries, world output for 1950-51 is estimated at 13 per cent less than in 1949-50. The withdrawal of American acreage

* Obtainable from H.M. Stationery Office, price 5s. (5s. 3d. by post).

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restrictions should, however, lead to a substantial increase in output next season.

Wool production continued to rise in 1949-50. Output in most of the producing countries (with the notable exception of the United States) was greater than in 1948-49. Nevertheless consumption in 1949 and 1950 exceeded output by some 10 per cent, and Joint Organization stocks were again heavily drawn on.

Rayon production was 41 per cent higher in 1949 than in 1938, and rose further in 1950. Production in 1949 was, in fact, almost 500 million lb. greater than world wool production in 1949-50 (clean basis). The level of output is still below the demand for rayon in its textile and industrial uses, and the shortage of raw materials such as sulphur may hamper further expansion. The output of *silk* was drastically reduced during the war and in 1949 was only 29 per cent of the 1938 total. *Flax* and *hemp* production continued to expand in 1949, but the output of *jute* fell because of the reduction in the Pakistan crop. In 1950, however, both India and Pakistan increased their *jute* production.

In the post-war period, as before the war, the Commonwealth produced virtually all the world supply of *jute*, almost half of the wool and about one-tenth of the rayon. The Commonwealth share in *hemp* production rose notably from 21 per cent before the war to 30 per cent after 1945, but the proportion of cotton fell from 18 per cent to 13 per cent, largely because of the reduced Indian output.

A study of world trade in industrial fibres shows that it rose in 1949 but was still below pre-war. The United Kingdom remained the chief importer, taking larger quantities of wool but smaller amounts of other fibres than in 1938.

Home-Grown Fruit and Vegetables : On the advice of the Advisory Committee on Standard Marketing Grades and Packs for Fruit and Vegetables, the Ministry of Agriculture and Fisheries has arranged for the 1951 season to supply growers and packers of some of the more important fruits and vegetables with package labels bearing a mark to identify wholesale consignments of fruit and vegetables packed to the Ministry's recommended grades and labelled by the packer with the grade names. In addition, the Ministry is prepared to lend printer's blocks to those growers and packers who undertake to pack according to the recommended grades and who wish to incorporate the Identification Mark in their own consignment labels or in the printing of container covers in which space is provided for the insertion by the packer of the grade names appropriate to the packed produce.

The purpose of the identification mark is to afford wholesale distributors and the Advisory Trade Panels on the wholesale markets an easy means of recognizing consignments packed to the Ministry's recommended grades, but it must be clearly understood by all concerned that during the trial period the use of the identification mark does not carry with it any undertaking by the Ministry in respect of the quality of the produce so marketed. This responsibility rests with the packer who must ensure that the grade name of the packed produce appears on the usual consignment label.

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For the 1951 trial period the following points should be noted :

- (a) Identification labels will be supplied, and printers' blocks will be loaned, free.
- (b) Identification labels will be of two kinds—one for sticking or stapling to rigid packages and the other for tying to bags or nets.
- (c) Identification labels are intended for use only by growers and packers who send consignments to wholesale distributors and only on consignments of certain fruits and vegetables (see below) which have actually been graded and packed according to the Ministry's recommended grades and which bear the grade names on the packers' labels.
- (d) Identification labels should not be affixed to every package labelled with the grade name but only to one in every ten or twelve packages in a graded consignment.

Growers and packers of *home-grown tomatoes and cucumbers* who undertake to adopt the recommended grades and label their packages with the grade names and require supplies of the National Grades Identification Label should apply for them either to the Secretary, Tomato and Cucumber Marketing Board, 10 Stanhope Gate, London, W.1, or to the Secretary, Ministry of Agriculture and Fisheries, Marketing Division, 36-38 Chester Terrace, Regent's Park, London, N.W.1.

Growers and packers of *plums, apples, pears and cauliflowers (or any home-grown vegetables marketed in bags or nets)* who propose to pack under the recommended grades should apply for Grades Identification Labels to the Secretary, Ministry of Agriculture and Fisheries, Marketing Division, 36-38 Chester Terrace, Regent's Park, London, N.W.1.

National recommended grades have been published for all the other home-grown fruit and vegetables of commercial significance, and although the Grades Identification Labels cannot be supplied free for these for the 1951 season, growers are urged in all cases to pack all their good marketable quality produce under the recommended grades, as defined in Marketing Guides (which may be had on application to the Marketing Division), and, where possible, to incorporate the Identification Mark design in their private brand labels. If there is a strong demand for the application of the Identification Mark to other graded fruits and vegetables, the free supply of Identification Labels for these products will be considered.

Productivity in Farming

The Report of a visit to the U.S.A. in 1950 by a Productivity Team representing the farming industry has just been published. Copies can be obtained from the Anglo-American Council on Productivity, 21 Tothill Street, London, S.W.1, price 2s. 6d. post free.

OFFICIALLY APPROVED CROP PROTECTION PRODUCTS

Since the date of the list published in the April, 1951 issue of AGRICULTURE (p. 47) the following names of proprietary products have been added to the approved list under the Ministry's Crop Protection Products Approval Scheme.

2, 4-D Sodium Salt Dusts :		
Ialine 2, 4-D Dust	Burt, Boulton and Haywood, Ltd.	BK 374
2, 4-D Sodium Salt Sprays :		
Daisykil	J. D. Campbell, Ltd.	BL 379
2, 4-D Amine Salt Sprays :		
Cornox	Boots Pure Drug Co. Ltd.	BM 365
Deepal	Pal Chemicals Ltd.	BM 363
Ialine 2, 4-D Spray (Liquid)	Burt, Boulton and Haywood, Ltd.	BM 373
Lornox	Boots Pure Drug Co. Ltd.	BM 364
Shell Weedkiller D	Shell Chemicals Ltd.	BM 378

Product R.235 has been withdrawn from the list by the Manufacturers.

Applications are now invited for the official approval of proprietary parathion (diethyl paranitrophenyl thionophosphate) miscible liquids, 20 per cent Tetra-ethyl pyrophosphate (HETP) miscible liquids, 40 per cent Tetra-ethyl pyrophosphate (TEPP) miscible liquids, and Tetra-ethyl pyrophosphate formulated products of the miscible type.

A booklet giving the list of Approved Proprietary Crop Protection materials may be obtained free on application to the Ministry (Publications) at 36-38 Chester Terrace, Regent's Park, London, N.W.1.

*Ministry of Agriculture and Fisheries, Plant Pathology Laboratory,
Harpenden, Herts. August, 1951.*

BOOK REVIEWS

Grassland and Grassland Products. STEPHEN J. WATSON. Edward Arnold. 21s.

Professor Watson has long been associated with investigations concerning the feeding value of grassland and grassland products. The desirability of replacing the system of feeding livestock on imported feed with one in which maximum utilization is made of pasture, has been continuously stressed by him. The present publication is one that will be particularly welcomed by the student as an exposition of the knowledge and trend of thought on the subject at the present time. For the more practically inclined, it will serve as an indication of the complexities arising when evaluation of pasture as a feedingstuff is being investigated. The author has drawn data from a wide field and the references given will allow the reader to pursue the subject more fully if he so desires.

Emphasis is laid upon the importance of grass as a feed for livestock and on the value of basing the economy of our livestock industry on grassland production. The chemical aspect of pasture evaluation and its relation to animal production receives attention, and the more conventional approach to grassland establishment has been largely replaced by one in which utilization is more fully discussed. The principles underlying the grass conservation practices—hay, dried grass and silage—are under review, and Professor Watson deals with the recent developments in these three fields. The merits of these products as feedingstuffs are considered from a farm economy standpoint, and the attention paid to silage is in line with modern practices of pasture production and management.

The theme developed is progressive in outlook and the acceptance of the principles outlined would alleviate the present feedingstuffs position on many of our farms.

G. P. H.

BOOK REVIEWS

Elements of Animal Nutrition. W. M. ASHTON. Griffin. 20s.

Dr. Ashton has provided a most useful guide for the student of agriculture on the rather complex subject of animal nutrition. This is an interesting, well written book, containing a fund of information necessary for the student, who, after his student days are over, will find it helpful as a book of reference.

The chemistry, digestion and digestibility of foods are fully discussed and there are chapters on succulent and concentrated foods, followed by a concise account of feeding standards and rationing. The work concludes with the more practical side of the application of rationing in the feeding of growing and fattening cattle, dairy cows, sheep, horses and poultry. It is this practical way of dealing with the nutrition of the animal which is so welcome, even though there is little outstanding in the way of new ideas or practices put forward.

The 200 pages cover a very wide field most admirably, but there are one or two points of criticism which I feel should be made. The two pages on the making of silage omit all mention of temperature, while a concise account of the methods of making good silage would have been preferable to a discussion on the difficulties likely to be encountered in the process. The statement "calcium deficiency also produces milk fever in dairy cows" needs further amplification, if that is possible; it might also have been wise to have left out any mention as to treatment. If we take the country as a whole, the systems of crossing given in the chapter on sheep, would not be considered suitable.

Notwithstanding these comments, *Elements of Animal Nutrition* is a book which will appeal to the student, and to the farmer interested in the practical and scientific side of stock feeding.

W. L.

National Institute for Research in Dairying Report, 1950. 3s.

The report deals briefly, but comprehensively, with the application of science to both the immediate and fundamental problems of the dairy industry. Much of the work it reviews is of a highly technical, and often of a speculative, nature, yet very few pages lack some strong reminder that the need to apply the results of dairy research to dairy practice is being continually borne in mind.

In experiments in progress at the Institute which set out to measure grassland output in terms of milk production, the results obtained in the wet summer of 1950 have indicated that in a wet year equipment and labour to deal with much larger quantities of grass silage are required if use is to be made of the full potential (i.e., never delaying cutting at the young, nutritive stage of growth) of modern, intensively-managed leys. In these experiments, the technique, which has been continued with success, of replacing animals in their sixth month of lactation by others in their second month, to maintain a fairly consistent average state of lactation in the herd, is likely to be of special interest to grassland experimentalists.

Trials with the "tetrapod" method of haymaking, which produced hay containing up to 20 per cent crude protein, are to be repeated next season. The view is expressed that many dairy farmers might do well to give the method a trial.

In studies of pre-partum milking, the udder secretions in the first 24 hours after calving, of cows milked an estimated 14 days before calving, have proved, like ordinary milk, to be of less value to the calf than normal colostrum.

Much attention is being paid to factors likely to affect milk quality. Recent experience shows that reducing the amount of roughage (hay) in the rations of cows leads to a fall in the butterfat content of the milk. This fact may be responsible also for the similar fall in milk fat which is associated with the grazing of lush spring pasture. On the other hand, spring pastures tend to increase the solids-not-fat in milk. Work is continuing at Shinfield to determine whether this increase is related to the recently discovered presence of oestrogens (the ovarian hormones which cause heat) in spring herbage.

Extensive trials of the North American practice of the churn immersion cooling of milk on many dairy farms in this country have indicated that the method is not so well suited to our conditions. Trials of this method, which is hygienic and which has labour saving possibilities, using refrigerated cooling, are, however, proving more promising.

The Report also contains some interesting data on effective substitute feedingstuffs for pigs; an account of a possible aid to the early diagnosing of pregnancy in cows; further reports on mastitis investigations, and a description of the artificial insemination work at the Ministry of Agriculture's Reading Cattle Breeding Centre which was, until 1945, under the direction of the Institute. Copies of the report are obtainable from the Secretary, National Institute for Research in Dairying, Shinfield, Reading.

A. J. L. L.

BOOK REVIEWS

Farm Mechanization Costs and Methods. CLAUDE CULPIN. Crosby Lockwood. 10s. 6d.

The rapid development in the mechanization of farm operations during the last twelve years has been accompanied by the publication of several books dealing with farm machinery, and it might have been thought there was not room for yet another, but in *Farm Mechanization Costs and Methods* Mr. Culpin has broken new ground. No attempt is made to describe the machines, as this was done adequately in the author's previous volume *Farm Machinery*. The present book deals with the economic aspects of the application of these machines and compares various methods of using them for most of the operations common to farm husbandry.

The obvious way of comparing different methods of doing the same job is to work out costs for each method. Very often the heaviest item in such costs is depreciation, and Mr. Culpin has wisely departed from the Income Tax wear and tear allowance scale, in which the rate of depreciation is based on a fixed percentage of the diminishing capital value. Under this scale if a new machine is being compared with a machine four years old, the great difference in the allowances for depreciation makes a true comparison of costs impossible. Another factor is that on some farms a tractor may do only 400 hours work a year and on other farms 1500 to 2000 hours. The yearly depreciation on the former would obviously be less than on the latter. By evaluating depreciation on the straight line method in terms of the anticipated life of each machine for the conditions in which it is working, Mr. Culpin arrives at what would seem to be a fair and correct way of costing. The figures he gives do not include overheads, so they are not the full costs; but they are sufficient for the purpose of comparing different methods of work.

Economists occasionally state that many farms are over-mechanized. Mr. Culpin approaches the matter from a practical angle and realizes that timeliness in many farm operations may well lead to such an increase in output or quality as to offset the extra depreciation incurred by having sufficient equipment to carry out jobs quickly when the soil conditions are just right. He does not overlook the planning of economical production. In fact the object of his book is to compare different methods in order to arrive at the one most economical for the particular farm. He gives many instances of costs of equipment and also hire charges, so that a comparison can be made between the advantages of hiring or of purchasing plant. For those about to buy a tractor he sets out the costs and fuel consumptions of the different types and his figures comparing the running costs with petrol, T.V.O., or diesel are most instructive. He also considers speed of work and gives suggestions for the most economic speeds for different operations. It is noted that for drilling he advocates a speed of 3-5 m.p.h. This is quite permissible for drilling corn, but for precision drilling of root crops it is much too fast. It would have been better if the two types of drilling had been mentioned separately, but this is a small omission in a book which otherwise is full of information of value to farmers, whether or not they are already mechanized. There are sixteen pages of well chosen illustrations.

C.B.C.

British Standards Yearbook, 1951. British Standards Institution. 7s. 6d.

An up-to-date account of the work of the British Standards Institution is given in the current Yearbook, and altogether it should prove to be a very useful reference book to the technical workers of many industries.

The aims of the Institution, which is of a national character, are to promulgate British Standard methods of test, codes of practice, terms, definitions, symbols and specifications. It is governed by a General Council which guides the general policy; four Divisional Councils direct the actual work of standardization, and fifty-six Industry Standards Committees, each representing a major British industry, distribute the work to Technical Committees and Sub-Committees, where commercial and technical knowledge is used to carry out each piece of work. The standards established by the Institution are evolved in accordance with the needs of industry, keeping in mind the interests of both producer and consumer, and, what is particularly important, they are reviewed from time to time to accord with technical and commercial developments.

Well over half of the four hundred pages of the Yearbook lists the 1,700 British Standards current at December 31, 1950, amplified by a short description to the subject-matter and scope of each, as well as work in hand, special issues, and translations. A subject index simplifies reference. Complete sets of British Standards are available for reference purposes at the B.S.I. libraries—one in London and another in Manchester.

The address of the British Standards Institution (Sales Department) is 24 Victoria Street, London, S.W.1.

J.L.

BOOK REVIEWS

Land Potential. T. W. EVANS. Faber. 12s. 6d.

Sustained production from our soil has for many generations been uppermost in the minds of the majority of farmers in this country. There are many well known rotations in use which take care of fertility but in recent years necessity has forced farmers to abandon such fixed rotations. With the rapid increase, during the war years, of arable land brought into being at the expense of permanent grassland, it is difficult to see how such departures could be avoided. Concurrently, many farmers have been using fertilizers in quantity for the first time with excellent results in crop yields. In his everyday work as an advisory officer, Dr. Evans has seen this happening and it has made him wonder what these practices are doing to the productivity of the soil, what farming practices over-exploit the natural resources of the land, and which of them do not make full use of the resources in relation to the main factors of environment—the inherent soil fertility and climate.

Basic to Dr. Evans's thesis there is the conception of a land potential for each farm, that is, the level of crop yields attained when all round good husbandry, suited to the environment, is practised. Attaining yields near the land potential is considered optimum production in so far as sustained yields are the criterion. Producing yields higher than the land potential leads to soil exploitation and, eventually to reduction of crop yields, while under-production may increase the stored fertility of the soil, though not necessarily so.

The dangers of producing crops in excess of the land potential are particularly stressed. Undoubtedly, the author has seen this occurring on farms but few facts are presented to illustrate the conditions under which such over-production can occur. It would have been most informative to farmers and technicians to have a few case histories of farms where yields greater than the land potential have brought about a marked loss of fertility. Perhaps the author considers that the wide dissemination of such knowledge would be dangerous.

The concept of the land potential is developed in the later chapters for the purpose of the measurement of farm productivity. The formula employed is simple and is based upon crop sales, livestock maintenance and production, and the quantities of purchased animal feedingstuffs. Food unit tables have been worked out to bring all these forms of farm production to a common unit. This simple formula can be extremely useful for measuring farm productivity quickly for the farmer's own information and assessing how near his management is to optimum production.

This method of measuring productivity is a most valuable contribution and aid to farmers and advisory officers. The author could well have devoted a little more space for a fuller explanation of the formula and the use of the conversion tables. Similarly, if all the data relevant to the formula were brought together into a single chapter, it would make for easier reading. The formula is introduced in Chapter 3, (surprisingly enough in a chapter entitled "All flesh is grass"), but it is not until Chapter 9 that the working of the formula is explained.

Dr. Evans has written of the necessity of maintaining the productivity of the land, having in mind that there is a limit to its production even with good husbandry. Over or under production may lead to impoverishment, and there is always a need everywhere for crop rotations and farming systems suited to the environment to balance output and input. Others have expressed similar thoughts but the author of this book has, with his formula, provided a yardstick with which the overall productivity of a farm can be measured. He has done so in a simple manner, which should not confuse even such persons as are immediately put off by the use of mathematical symbols.

T.E.W.

Nature Through the Year. FRANCES PITT. Macmillan. 18s.

This is another "mixture as before," being a delightfully written, discursive account of the habits and activities month by month of both wild life and tamed, and including a number of well-known facts of natural history, together with a generous sprinkling of less known or newly discovered facts. It is of primary interest to the beginner in the study of beasts and birds, yet so well leavened with new items that the already knowledgeable are likely to be held from the first page to the last, lest anything be missed. I recommend it unhesitatingly to all teen-agers interested in nature and to any adults new to country life. The book is not cheap but it gives full value for money, not only in text but also in the many interesting photographs, all taken by the author. These alone show, if that were necessary, that Miss Pitt really does know intimately—from patient personal observation—the creatures of whom she writes. But I wish the punctuation were better! When reading for information it is irritating to have to retrace one's steps so often to be sure of the meaning.

E.M.B.

BOOK REVIEWS

Population Genetics and Animal Improvement. I. MICHAEL LERNER. Cambridge University Press. 30s.

This book deals mainly with the character of egg production in fowls and is addressed primarily to research workers, teachers and advanced students of genetics. Such an audience may be relied upon to accept the general views of Goodale and his successors that the inheritance of fecundity should be studied by partitioning it into components such as age at sexual maturity, persistency and so on, but to reject the claims of that school that inheritance can then be satisfactorily explained on a small number of mono- and di-factorial bases. They insist, and apparently with irresistible logic, on a polygenic approach, necessitating strict statistical analysis of data obtained in the field. What this involves in theory and practice is well developed in the text and, while much of it is likely to be incomprehensible to the ordinary poultry breeder, considerable portions of the book are not only very readable but are of first-class importance to the pedigree breeder.

Professor Lerner supports his theories and advice with evidence from his own flocks of White Leghorns at the University of California, where pullet-year egg production has been raised from about 125 to 1933 to about 220 in 1944. In view of the fact that he interprets his results as a gain of some 5.6 eggs per annum (on average), based largely on selection for certain components of the fecundity character, it is unfortunate that no comparable extension of all the data reported in Table 4 is available for later years.

G.E.M

Warwickshire (Vision of England Series). TUDOR EDWARDS. Paul Elek. 15s.

Tudor Edwards, a Warwickshire man himself, proves an admirable guide to this "core and centre of the English world" and he shows that the county, although justifiably proud of her playwright son, deserves consideration for associations other than those implied in the universal title of "the Shakespeare Country".

Mr. Edwards shows an extremely extensive and detailed knowledge of the county; there is hardly a town, village or even hamlet which does not receive some mention. His journeyings start in "the heart of England," from Meriden, Coleshill, Coventry and thence to Rugby and the eastern plain. He passes on to the lias country with its glimpse of the Cotswolds and its villages of Hornton stone, pausing to admire particularly that celebrated house at Compton Wynates; then to Stratford itself with a peep at its surrounding villages, and from there to the medieval and Regency towns of Warwick, Leamington and Kenilworth. The villages of Arden, with their many historical associations, deservedly receive a chapter of their own, as does Birmingham which, in spite of the "smoke on the horizon," has its own architectural riches. Finally, to the northern fringe, he visits the industrial towns of Nuneaton and Atherstone, and surrounding villages, many of which have been framed by the pen of George Eliot.

Throughout the book, Warwickshire's riches, both in history and architecture, are excellently described and extremely well illustrated with attractive drawings by James Arnold and sixty-nine striking photographs. But the Warwickshire countryside has many other attractions—its leafy lanes and winding streams, its rich lias clay wheat lands and its fertile Avon terraces—which have little, if any, mention and for this reason to the country-lover and the agriculturist this book may, therefore, prove disappointing.

S.E.T.

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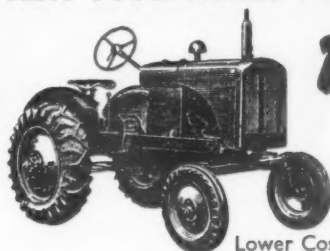
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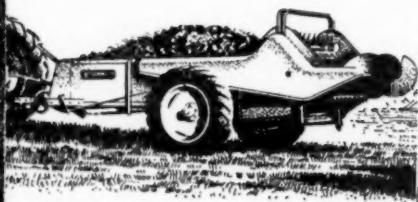
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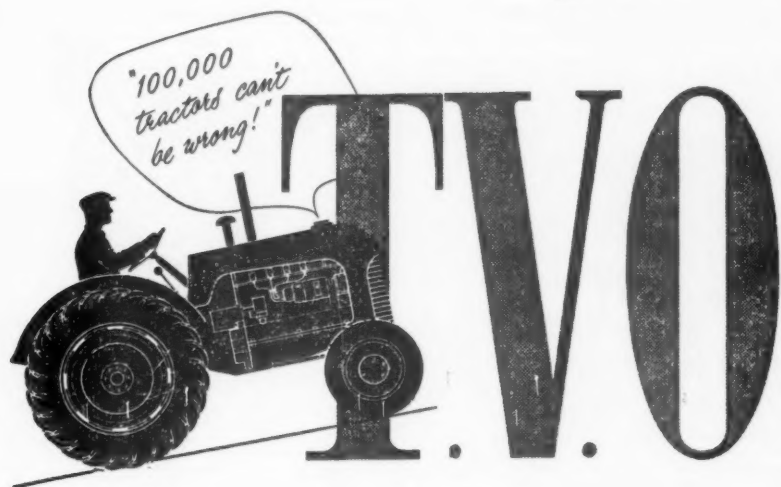
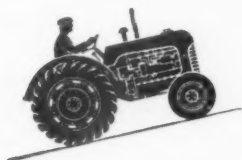


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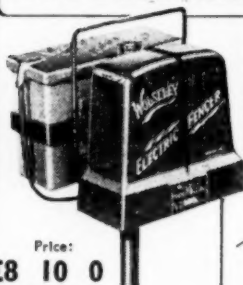
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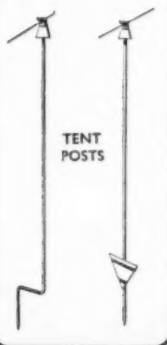
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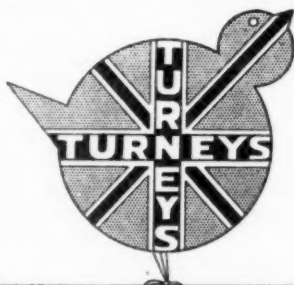
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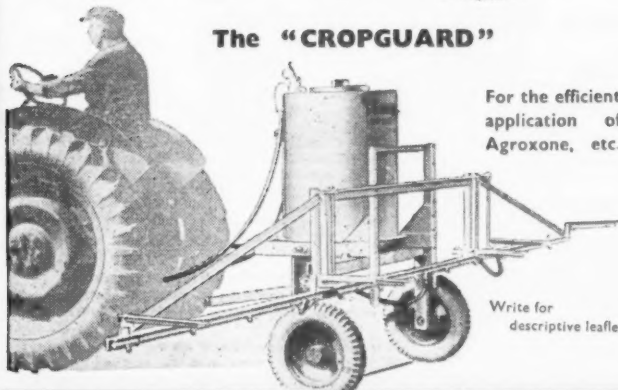
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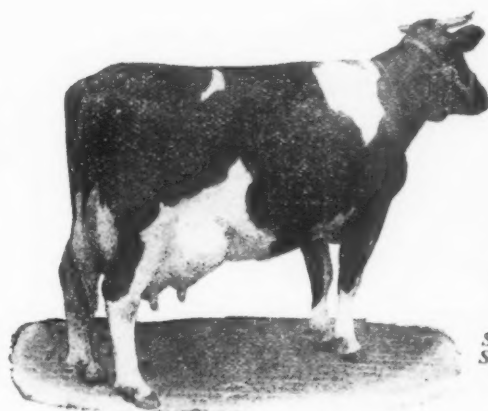
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